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KAIPAROWITS
ENVIRONMENTAL IMPACT STATEMENT

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ABBREVIATIONS, GLOSSARY, BIBLIOGRAPHY AND APPENDICES

final

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ABBREVIATIONS
(General)

ac - alternating current
AEC - Atomic Energy Commission
ANFO - ammonium nitrate fuel oil
APS - Arizona Public Service
(aq) - aqueous or hydrated
AQCR - Air Quality Control Region
AQMA - Air Quality Maintenance Area
ASW - administration building, shop and warehouse
AT&T - American Telephone and Telegraph Company
BLM - Bureau of Land Management
BOD - biological oxygen demand
CFR - Code of Federal Regulations
CPUC - California Public Utilities Commission
dc - direct current
E - east
EIS - environmental impact statement
E.O. - executive order
EPA - Environmental Protection Agency
ERCDC - Energy Resources Conservation and Development Commission
ERDA - Energy Research and Development Administration
ESP - electrostatic precipitator
F - Fahrenheit
FEA - Federal Energy Administration
FP - fluorescent particle
HV - high voltage direct current
KCDC - Kaiparowits Community Development Corporation
LA - Los Angeles
LADWP - Los Angeles Department of Water and Power
LCC - Load carrying capability
MESA - Mine Enforcement and Safety Administration
MRI - Meteorology Research Inc.
MSFE - multi-state flash evaporator
MSL - mean sea level
N - north
NOAA - National Oceanic and Atmospheric Administration
NPS - National Park Service
NRA - national recreation area
NRL - national resource land
NSPS - federal New Source Performance Standards
ORV - off-road vehicle
OSHA - Occupational Safety and Health Act
PDAC - Kaiparowits Planning and Development Advisory Council
PL - public law
PSDR - federal Prevention of Significant Air Quality Deterioration Regulations
R - range
R-O-W - right-of-way
RS - revised statutes
S - south
SAR - sodium absorption ratio

SCAG	- Southern California Association of Governments
SCRTD	- Southern California Rapid Transit District
SCE	- Southern California Edison
SDG&E	- San Diego Gas and Electric Company
SLM	- Salt Lake Meridian
SRP	- Salt River Project
SSR	- subsynchronous resource
Stat.	- statutes
SWES	- Southwest Energy Study
T	- township
TDS	- total dissolved solids
T/L	- transmission line
UP&L	- Utah Power and Light Company
USC	- United States Code
USGS	- United States Geological Survey
W	- west
WSCC	- Western Systems Coordinating Council

(Chemical)

$CaCO_3$ - calcium carbonate

$Ca(OH)_2$ - calcium hydroxide

$CaSO_3$ - calcium sulfite

$CaSO_4$ - calcium sulfate

CO_2 - carbon dioxide

CuO - copper oxide

$CuSO_4$ - copper sulfate

H_2 - elemental hydrogen

H_2O - water

H_2S - hydrogen sulfide

H_2SO_4 - sulfuric acid

$KAl_3\ (OH)_6(SO_4)_2$ - hydrous potassium aluminum sulfate

MgO - magnesium oxide

$Mg(OH)_2$ - magnesium hydroxide

$MgSO_3$ - magnesium sulfite

$MgSO_4$ - magnesium sulfate

Na_2SO_3 - sodium sulfite

$NaHSO_3$ - sodium bisulfite

NO_x - nitrogen oxide

NO_2 - nitrogen dioxide

O_3 - ozone

S - elemental sulfur

SF_6 - sulfur hexafluoride

SO_2 - sulfur dioxide

SO_3 - sulfur trioxide

V_2O_5 - vanadium pentoxide

(Units of Measure)

AUM - animal unit month

bbl/yr - barrels per year

Btu - British thermal unit

cm - centimeter

db - decibels

ft^3/day - cubic feet per day

g - gram

gal/min - gallons per minute

in-Hg abs - inches of mercury absolute

km - kilometer

kV - kilovolt

m - meter

maf - million acre-feet

mg/ℓ - milligrams per liter

mi/h - miles per hour

MW - megawatts

ohm - measure of electrical resistance

pCi/g - picocuries per gram

pH - measure of acidity and basicity

pphm - parts per hundred million

ppm - parts per million

psi - pounds per square inch, may also be expressed as lb/in^2

ton/acre - tons per acre

ton/day - tons per day

ton/h - tons per hour

tons/yr - tons per year

$\mu g/m^3$ - micrograms per cubic meter

GLOSSARY

AASHO classification (soil engineering). The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acre-foot. The quantity of a material that will cover 1 acre of land 1 foot deep.

Adiabatic. Denotes a process (such as a parcel of air undergoing expansion or compression) in which there is no transfer of heat energy into or out of the system.

Adiabatic lapse rate. The change in air temperature with altitude. In well-mixed air the dry adiabatic lapse rate is 5.4° F per 1,000 feet (0.98° C per 100 m).

Aerosol. Particles suspended in air.

Aesthetics. The philosophy concerned with the perception of beauty. Visual perception of the beauty of landscapes involves the viewer's ideas, sensations, and feelings about what he sees, as well as the physical elements that compromise the view.

Agglomerate. To fuse into a mass.

AGL. (Above ground level), a height measured in feet or meters above the ground.

Alkaline soil. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

Alkali soil. 1: A soil with a high degree of alkalinity (pH of 8.5 or higher) or with a high exchangeable sodium content (15 percent or more of the exchange capacity) or both. 2: A soil that contains sufficient alkali (sodium) to interfere with the growth of most crop plants.

Alluvial soils. An azonal great soil group developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.

Alluvium. Clay, silt, sand, and gravel or other rock material transported by flowing water and deposited as sorted or semi-sorted sediments.

Ambient air. Surrounding or circulating air.

Ambient air quality standard. A concentration of an air pollutant in the air for a specified time period designated to be the allowable maximum to protect public health (primary) or welfare (secondary).

Ammonium nitrate fuel-oil prill. A globular, porous particle obtained by spraying ammonium nitrate and fuel oil in a rising current of warm air. Used in blasting.

Angle of repose. Angle between the horizontal and the maximum slope that a soil assumes through natural processes.

Animal unit month. A measure of forage or feed requirement to maintain one animal (cow or five sheep) for a period of 30 days. Abbreviated: AUM.

Annual plant. A plant that completes its life cycle and dies in one year or less.

Anticline. Strata which dip in opposite directions from a common ridge or axis, like the roof of a house. A fold where beds are arched so as to incline away from each other.

Aquifer. A layer of rock, sand, or gravel that contains water and that will deliver it in usable quantities to wells.

Aquatic. Pertaining to or living in water.

Aquifer skeleton. The mineral framework of a water-bearing zone or aquifer.

Archaeological excavation. The scientifically controlled recovery or salvage of a site designed to yield maximum information about the life of the inhabitants their ways of solving human problems, and of adjusting to and modifying their natural environment.

Archaeological inventory. A presentation and summation of the data presently known concerning an area.

Archaeological resources. Objects and areas made or modified by man and the data associated with these artifacts and features. These resources rest in or on the ground.

Artifact. A material object made or modified in whole or in part by man. Among the most common artifacts on archaeological sites are fragments of broken pottery (sherds), and stone tools, chips, projectille points, and similar lithic debris.

Ash. Noncombustible mineral matter contained in coal. These minerals are generally similar to ordinary sand, silt, and clay in chemical and physical properties.

Atmospheric stability. A measure of the extent to which vertical and horizontal mixing will take place. Commonly measured as unstable, neutral or stable.

Available water-holding capacity (soils). The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil.

Back country. Areas which are essentially roadless. Effects of man may be present but are inconspicuous or unobtrusive.

Background air quality. The quality of air without significant local sources of man-made air pollution.

Biomass. Living mass per unit area per unit time.

Blowdown. Water drawn from cold water basins of cooling towers to prevent buildup of solid concentrates. Usually contains chemicals used for pH adjustment and slime control.

Botanical site. An area where there are plant or plant communities which have a special human interest value.

Btu. An abbreviation for British thermal unit, usually considered to be that amount of heat needed to raise the temperature of one pound of water from 63° F to 64° F.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibily when treated with cold, dilute hydrochloric acid.

Slightly calcareous	1 to 3 percent lime
Moderately calcareous	3 to 15 percent lime
Strongly calcareous	15 to 40 percent lime
Very strongly calcareous	more than 40 percent lime

Chaining. The removal of the pinyon-juniper or sage brush vegetative type by dragging a large anchor chain over the area and pulling the trees over.

Chaparral. A dense growth of low, evergreen oak.

Class. A group of plants or animals ranking above an order and below a division (phylum).

Clay. As a soil separate, the mineral soil particles are less than 0.002 millimeters in diameter. As a soil textural class, the soil material is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coal measures. Formations containing coal beds.

Colluvial, colluvium. Loose and incoherent deposits consisting of alluvium and angular fragments of rocks usually at the foot of a slope or cliff and brought there by gravity.

Community. An assemblage of organisms living together and interacting with each other in a characteristic natural habitat.

Coning plume. Effluent plume, shaped like a cone with a horizontal axis, usually occurring in a neutral atmosphere with wind velocity greater than 20 mi/h.

Corridor. A corridor is a strip of land of undefined width that, based on ecological, technical, and economic factors, is more suited for utility rights-of-way than adjacent lands.

Cover. Shelter needed or available for animals.

Crucial habitat. That part of the natural environment of an animal which if lost, would lead to the animal's demise.

Cultural values. Value of places, objects, and structures that are important to the present day activities of subcultures existing in this country. Such areas are important and have value, not because of public educational or historic interests, but because they are vital to the preservation of a subculture.

Cyclonic storms. Large storm systems (50 to 900 miles in diameter or more) characterized by air rotating around a center of low pressure. More common in winter than summer. Rainfall and snowfall associated with such storms may be light, but may persist for two to three days or longer.

Decomposer. Primarily bacteria and fungi which ingest food by absorption.

Deposition. The set of physical processes that transfer a substance from the atmosphere to the Earth's surface.

Depth, soil. The thickness (in inches) of soil that plant roots can readily penetrate to obtain water and nutrients. Deep soils are more than 40 inches; moderately deep soils are 20 to 40 inches; shallow soils are 10 to 20 inches; and very shallow soils are less than 10 inches.

Dew Point. The temperature to which air must be cooled in order for saturation to occur.

Diffuse solar radiation. Radiation from the sun reaching an observation point indirectly by scattering in the atmosphere.

Direct solar radiation. Radiation from the direct rays of the sun reaching an observation point.

Dispersion. The physical process of diluting the concentration of a substance in a fluid by molecular and turbulent motion; e.g., smoke in air.

Dissolved solids. The dissolved chemical constituents in water; concentration is commonly expressed in milligrams per liter (mg/ℓ).

Diurnal. Showing a periodic alteration of condition with day and night.

Drainage, natural soil. This term refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized:

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the A and B horizons. They have uniformity of color in the A and upper B horizons and have mottling in the lower B and C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time. For example, Podzolic soils commonly have mottlings below a depth of 6 to 16 inches, in the lower A horizon, and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be minimal or absent in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Dry adiabatic lapse rate. Decrease in temperature with height at a rate of 1 degree Centigrade per 100 meters.

Ecosystem. A system formed by the interrelationship of the living and non-living things within their environment.

Emission standard. Limitations to the permissable discharge into the atmosphere of pollutants such as particulates, sulfur oxides and nitrogen oxides.

Endangered species. Those species in danger of extinction throughout all or a significant portion of their range.

Entrainment. A process of transferring by turbulence a substance into a moving fluid; in this case, the transfer of dust and sand into the atmosphere by wind.

Environment. The total of conditions surrounding an entire organism.

Epidemicological. Affecting at the same time a large number of persons in a locality.

Erosion. The wearing away of the land surface by wind (sandblast), running water, gravity and other geological agents.

Erosion pavement. The small surface gravel which is left on the land after the soil is eroded away.

Escarpment. A long, clifflike ridge of land, usually formed by faulting or fracturing of the earth's crust.

Eutrophication. The aging process of lakes and bays whereby depths of the bodies of water become shallower due to the deposition of sediment and vegetation. Such bodies of water have a greater primary food production, but summer stagnation may be severe enough to exclude cold-water fishes.

Fanning plume. Effluent plume with very little vertical spread but a meandering trajectory in the horizontal plane. Characteristic of a plume emitted under extreme inversion conditions.

Fault. A fracture or fracture zone along which there has been displacement of the two sides relative to one another, parallel to this fracture plain.

Fauna. All the animal life in a given region or period of time.

Flood plain. A nearly level land surface consisting of stream sediments that borders a water course and is subject to flooding unless protected artificially.

Flora. All the plant life in a given region or a period of time.

Fly ash. The solid particles that are carried out of a combustion furnace in the exhaust gas flow.

Food chain. A group of plants and animals linked together by their food relationships.

Fumigation. Rapid mixing of a fanning plume down to the ground, such as during inversion breakup.

Game species. Wildlife species which are hunted or pursued.

General leisure. Activities which support the participation in, or involve the observation of, other activities. Includes camping, picnicking, and other similar recreation pursuits.

Geologic site. Any unusual or attractive geological phenomenon with special human interest value.

Gradient wind level. Upper limit of frictional influence of the earth's surface, usually between 1 and 2 km.

Gunite. A light mortar used for sealing walls, ditches and other surfaces.

Gypsum soils. Soils which contain high amounts of hydrated calcium sulfate ($CaSO4, 2H_2O$), occurring in crystals and in masses. Calcium sulfate is water soluble and will dissolve out of the soil profile when exposed to high amounts of water, which in turn creates a piping affect (a downward or lateral movement of water through the soil).

Habitat. The natural environment of a plant or animal. The place where they are usually found.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be gravelly, sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substances.

Heavy Metals. Metallic elements generally occurring in trace amounts in water; including iron, manganese, copper, aluminum, zinc, cadmium, chromium, lead, arsenic, mercury, and vanadium.

Herbivores. Animals which feed upon plants exclusively.

Historic site. Any place associated with a significant event, an important person, or a cultural activity of the past. Historic in most cases is 50 years old or older, except for rare instances where exceptional events have taken place such as the site of the first atom bomb detonation.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

These are the major horizons:

O horizon - The layer of organic matter on the surface of a mineral soil, consisting of decaying plant residues.

A horizon - The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon - The mineral horizon just below an A horizon. The B horizon is in part a layer of change from the overlaying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum.

C horizon - The weathered rock material immediately beneath the solum. In most soils, this material is presumed to be like that from which the overlying horizons were formed.

R layer - Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Hunting. Lawful attempts to take game animals.

Incised. Cut down into, as a river cuts into a plateau.

Insolation. Solar radiation received at the earth's surface.

Intensive archaeological reconnaissance. An on-the-ground surface survey and testing of an area sufficient to permit determination of the number and extent of the resources present, their scientific importance, and the time factors and cost of preserving them or otherwise mitigating any adverse affects on them.

Intermittent stream. A stream which shows a flow of water only part of the time, usually in the spring, following the winter thaw, or following a heavy rainstorm.

Inversion. A change of temperature with height greater than -1°C/100m. therefore no change with height (isothermal) or an increase with height would be classified as an inversion.

Isopleths. Line of equal or constant value of a given quantity with respect to space or time.

Isothermal. No temperature change with height.

Lapse rate. The change of temperature with height. A "lapse" condition usually means a decrease with height.

Lime. Lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soils. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Lithic Calciorthids . Soils that have had much lime in the parent material or added in dust. Low rainfall is unable to remove the lime completely from the surface soil to a depth of 7 inches unless the texture is sandy. Most of these soils are calcareous in all horizons and have a rock layer within 20 inches of the soil surface.

Lithic Ustic Torriorthents. Soils with a recent erosional surface, receiving most of their moisture during the summer months, the soil temperature at the depth of 20 inches is 41° F or higher and has a rock layer within 20 inches of the soil surface.

Lithic Ustollic Calciorthids. These soils have the same characteristics as the Lithic Calciorthids but are dry three-fourths of the year, receive moisture during the summer months and have a mean annual soil temperature of 47° F or higher.

Looping plume. Effluent plume being rapidly spread upward and downward by thermally induced eddies. Occurs in a highly unstable atmosphere because of rapid mixing.

Megawatt. One million watts, a unit of power or energy per unit time.

Micron (ξ). One millionth of a meter, more properly called a micrometer (ξm).

Millibar. Pressure unit of 1,000 dynes per square centimeter.

Mixing height. Height of the layer of air where well-mixed conditions exist, usually the height of the first significant inversion above the surface.

Monocline. Beds inclined in a single direction.

Mottled. A description for soils irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms and their meaning include abundance: few, common, and many; size: fine, medium, and coarse; and contact: faint, distinct, and prominent. The size measurements include: fine, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from five millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

MSL. (Mean sea level) The height measured in feet or meters above sea level.

National register of historic places. A listing maintained by the National Park Service of architectural, historical, archaeological, and cultural sites of local state, or national significance.

Nephelometer. General name for instruments which measure, at more than one angle, the scattering function of particles suspended in a medium.

Neutral atmosphere. An atmospheric condition in which the air cools, as altitude increases at the normal, dry adiabatic temperature lapse rate: 0.98° C for every 100 meters.

Non-game species. Wildlife not classified as game species, and not typically pursued by hunters.

Nonspecular. Not shiny.

Off-road vehicle. Any vehicle (including the standard automobile) designed for, or capable of, travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain. It includes, but is not limited to: four-wheel drive or low-pressure tire vehicles, motorcycles and related two-wheel drives, snowmobiles, amphibious machines, ground-effect or air-cushion vehicles, recreation vehicle campers, and any other means of transportation deriving motive power from any source other than muscle, except that such terms exclude motorboats.

Opacity. The degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

Oxidant. A gas that oxidizes; usually ozone.

Parent material. The disintegrated and partly weathered rock from which soil is formed.

Particulate. Minute particles of coal dust, fly ash, and oxides temporarily suspended in the atmosphere.

Perennial. (Plants) A woody or herbaceous plant living from year to year, not dying after once flowering.

Perennial. (Streamflow) Streams that flow throughout the year from source to mouth.

Permeability. The quality of a soil horizon which enables water or air to move through it. Terms and rates in inches per hour used to describe permeability are as follows: very slow - less than 0.06, slow - 0.06 to 0.2, moderately slow - 0.2 to 0.6, moderate - 0.6 to 2.0, moderately rapid - 2.0 to 6.0, rapid - 6.0 to 20.0, and very rapid - more than 20.0.

pH. A number that represents the negative logarithm, base 10, of the hydrogen-ion activity of a solution. A pH less than 7 indicates an acid solution; a pH greater than 7, an alkaline solution.

Photochemical. Referring to chemical reactions that require light.

Photometry. A physical method of measurement based on the transmission of light.

Picnicking. Day use activities related to an excursion or outing where food is usually provided and consumed at a recreation site (developed or undeveloped).

Picocurie. One trillionth (million millionth or 10^{-12}) of a curie, a measure of radioactivity.

Pilot balloon. Small balloon with known ascent rate whose track is followed by a theodolite (optical tracking instrument similar to a surveyor's transit) in order to obtain data for the computation of speed and direction of winds in the upper air.

Plume. A large conspicuous cloud of smoke, dust, or water vapor arising from a stack.

Precipitator (electrostatic). Device employing principles of electromagnetic removal of particles from air.

Preliminary archaeological reconnaissance. An on-the-ground surface examination of selected portions of an area adequate to assess the general nature of the archaeological resources probably present.

Primitive areas. Natural, wild, and undeveloped areas essentially removed from the effects of civilization.

Profile, soil. A vertical section of the soil through all it's horizons and extending into the parent material.

Protected. An animal which may not be taken in any manner.

Radiational cooling. Cooling of the earth's surface and adjacent air accomplished mainly at night whenever the earth's surface suffers a net heat loss.

Radiation inversion. Increase of temperature with height starting at the surface of the earth and due to radiational cooling.

Rainout. Particulate or gaseous matter removal from the atmosphere due to association of the matter with the precipitation element before its descent.

Raptors. Birds which prey on other animals; birds of prey.

Rare. A rare species is one that although not presently threatened with extinction is in such small numbers throughout its range that it may be endangered if its environment is adversely affected.

Rawinsonde. Method of upper-air observation consisting of a computation of wind speed and direction, temperature, pressure and relative humidity by means of a balloon-borne radiosonde tracked by radar.

Relative humidity. Ratio of the actual vapor pressure of the air to the saturation vapor pressure.

Riparian. Vegetation and/or animals dwelling along a perennial stream, or body of water.

Rockiness. A description of rock expressed as a volume percentage of the surface. General classifications are:
Class 0 - less than 2 percent, Class I - 2 to 10 percent (rocky),
Class II - 10 to 25 percent (very rocky), Class III - 25 to 50
percent (extremely rocky), Class IV - 50 to 90 percent (rockland)
and Class V - over 90 percent (rock outcrop).

Runoff. Refers to the rate water moves by flow over the surface of the soil. Rates are slow, medium, and rapid.

Sand. As a soil separate, the individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. As a soil textural class, soil material that is 85 percent or more sand and not more than 10 percent clay.

Scrubber. An apparatus designed to remove impurities from gases.

Sediment yield. The amount of soil an area loses every year through natural processes, usually expressed in acre-feet per square mile per year. One acre-foot per square mile per year, reduced to simpler terms, means that a square mile of land loses about .01 inches of soil every year. This is a result of the normal and ongoing processes of water and wind erosion.

Shrink-swell. Describes that soil quality that determines its volume change with change in moisture content.

Silt. As a soil separate, the individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil material that is 80 percent or more silt and less than 12 percent clay.

Skeletal. Soils that are very poorly developed and exhibit little or no horizonal development in the soil profile.

Slurry. A mixture of water and powdered coal, commonly in roughly equal proportions by weight.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. Describes the combined A and B horizons of the soil profile. If the soil lacks a B horizon, then the A horizon is the solum.

Stable atmosphere. A condition characterized by a temperature change with height greater than -1°C/100 m (see inversion).

Standard Metropolitan Statistical Area (SMSA). A county or group of contiguous counties which contains at least one city of 50,000 inhabitants or more, or "twin cities" with a combined population of at least 50,000.

Status, undetermined. A species or subspecies which has been suggested as possibly threatened with extinction, but about which there is not enough information to determine its status.

Stones. Rock fragments greater than 10 inches in diameter, if rounded, and greater than 15 inches along the longer axis, if flat.

Stoniness. Fragments of rock particles over 10 inches in diameter expressed as a volume percentage of the surface. Class 0 - no stone, Class I - from none to 0.1 percent, class II - 0.1 to 3 percent, class III - 3 to 15 percent, class IV - 15 to 90 percent and class V - over 90 percent.

Stratigraphy. That branch of geology which treats of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

Subsidence inversion. Air inversion aloft caused by sinking air within a high pressure system which causes the temperature at the top of the layer to increase more than the temperature at the bottom of the layer. The effect is the creation of a limited mixing volume below the stable layer.

Subsoil. Describes the B horizon of the soil profile roughly, the part of the solum below plow depth.

Substratum. Describes the part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon and has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Susceptibility to erosion. This could be a confusing term because most soils generally are stable in their natural condition. However, when a soil is disturbed, it can become susceptible to erosion to either a slight, moderate, or severe degree.

Syncline. A fold in rocks in which the strata dip inward from both sides toward the axis. The opposite of anticline.

Synergistic. Cooperative action of discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

Synoptic pressure pattern. Pattern of isopleths (see glossary definition) of constant pressure over a horizontal surface (usually mean sea level) at a given time. Can also mean isopleths of height of a given pressure at a given time.

Techtonic. Of, pertaining to, or designating the rock structure and external forms resulting from the deformation of the earth's crust. As applied to earthquake, it is used to describe shocks not due to volcanic action or to collapse of caverns or landslides.

Terrestrial. Belonging to or living on the ground or earth.

Texture, soil. Describes relative proportions of sand, silt and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay. Coarse, fine and very fine may be used to modify the basic textural class.

Threatened Species. Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Turbidity. A measure along the line of sight of the attenuation of solar radiation in a clear sky due to atmospheric suspensoids.

Typic calciorthids. These soils have a high content of lime in the parent material or added in dust. The low rainfall is unable to remove the lime completely from the surface soil to a depth of 7 inches unless the texture is sandy. Most of these soils are calcareous in all horizons. These soils are not saturated with water for 90 consecutive days or more in most years within 40 inches of the surface. There is no rock layer within 20 inches of the soil surface. The soil temperature is 41^{o} F or higher at a depth of 20 inches.

Typic Haploborolls. These soils are mostly cool, but not cold, and are found in late Pleistocene or Halocene deposits or on land surfaces of those ages. The soil textures in the upper 30 inches are coarser than loamy, fine sand. There is also a regular decrease in organic content with increasing depth. There is no rock layer within 20 inches of the soil surface.

Typic Torriorthents. These soils have a mean annual temperature of 48° F and receive 6 inches of rainfall a year. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick. The soil profile is not saturated with water within 60 inches of the soil surface at any time of the year in most years. There is no rock layer within 20 inches of the soil surface.

Typic Torripsamments. These soils consist of sands receiving six inches of rainfall a year which then are formed into either moving or stabilized dunes. These sand deposits are of late Pleistocene age or younger. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick. These soils are dry three quarters of the time and have a mean annual soil temperature of 41° F. There is no rock layer within 20 inches of the soil surface.

Typic Ustorthents. These soils are deep to moderately deep over hard rock and have no clayey texture and a swelling type clay. There is no horizon within 40 inches of the soil surface that is 6 inches thick. The soil profile is not saturated with water within 60 inches of the soil surface for as long as one month in most years. There is no rock layer within 20 inches of the soil surface.

Unstable atmosphere. A condition characterized by a temperature decrease with height greater than the standard adiabatic lapse rate of 1° C per 100 meters. Marked vertical mixing occurs and pollutants are rapidly dispersed.

Ustic Torrifluvents. These soils are formed from recent water-deposited sediments and are not flooded frequently or for long periods of time. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick. These soils are also either alkaline or calcareous. They are dry three quarters of the time, receive moisture during the summer months and have a soil temperature of 41° F at the 20 inch depth.

Ustic Torriorthents. These soils have a mean annual temperature of 48° F and receive 6 inches of rainfall a year. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick. The majority of the moisture occurs during the summer months. The soil profile is not saturated with water within 60 inches of the soil surface at any time of the year in most years.

Ustic Torriorthents (shallow). These soils are the same as the Ustic Torriorthents but are only 10 to 20 inches deep.

Ustollic Calciorthids. These soils differ from the Typic Calciorthids in that they have more organic matter and more moisture. They receive most of their moisture during the summer months.

Ustollic Camborthids. These soils have a subsoil horizon whose texture is finer than loamy, fine, sand in which the materials have been altered or removed. The mean annual temperature is 48° F or higher. These soils contain higher than normal amounts of organic matter and moisture. However, they are not saturated for 90 consecutive days or more in the upper 40 inches of the profile in most years. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick.

Ustollic Haplargids. These soils contain high amounts of organic matter and receive the majority of their moisture during the summer months. There is an accumulation of silicate clays in the B horizon of the soil profile, usually within 20 inches of the soil surface. The texture is finer than loamy, fine, sand above a depth of 20 inches. The soil is not saturated with water for 90 days in most years. There are no horizons within 40 inches of the soil surface that are greater than 6 inches thick. There is no rock layer within 20 inches of the soil surface.

Visibility. The greatest distance in a given direction at which it is possible to see and identify with the unaided eye a prominent dark object against the sky at the horizon.

Washout. Particulate or gaseous matter removal from the atmosphere due to association of the matter with precipitation elements during their descent.

Wet cooling tower system. This system utilizes evaporation of some of the condenser cooling water to cool the remainder and discharges the heat of evaporation into the atmosphere.

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APPENDIX I-1

Final Report
Kaiparowits Project Energy Analysis

Federal Energy Administration

FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D.C. 20461

OFFICE OF THE ASSISTANT ADMINISTRATOR

DEC 3 0 1975

Mr. Frank Snell
Program Manager
E.I.S. Core Team/Kaiparowits
Utah State Office, Box 11505
Salt Lake City, Utah 84111

Dear Mr. Snell:

Enclosed is the revised Final Report of the Kaiparowits Project Energy Analysis which was prepared in conjunction with the Kaiparowits Environmental Impact Statement. It incorporates the data forwarded to us by your October 23 letter.

I believe the report adequately describes the necessity for the Kaiparowits Project in terms of reducing our dependence upon imported oil and natural gas.

I trust this report will satisfy your requirements associated with this Environmental Impact Statement.

Sincerely,

William G. Rosenberg
Assistant Administrator
Energy Resource Development

Enclosure

Final Report

Kaiparowits Project Energy Analysis

Office of Energy Resource Development
Federal Energy Administration
Washington, D.C. 20461

Original Report of February 4, 1975

Revised on December 3, 1975 to reflect receipt of new data.

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PREFACE

This report concerns the proposed Kaiparowits Project, a 3000 megawatt coal-fired, baseload electric generating station to be constructed in Southern Utah. The discussion considers the need for Kaiparowits generating capacity and possible alternatives to the Kaiparowits Project in satisfying this need. This report also addresses briefly the use of energy and water resources, now destined for the Kaiparowits generating station, for purposes other than generation of electric power. Not considered are public policy options (e.g., restructuring of electric power rates or mandatory conservation) which would have a widespread impact on energy matters and, in so doing, affect the need for Kaiparowits and/or the merits of its alternatives.

The origin of this study was a request from the Bureau of Land Management (BLM) to the Federal Energy Administration (FEA). The BLM sought information which could be used in preparation of the "conservation alternatives" section of an Environmental Impact Statement being written in conjunction with the transfer of a power plant site from Federal ownership to the State of Utah. The FEA, in furtherance of its effort to stimulate more comprehensive energy discussion in Environmental Impact Statements, undertook to provide the requested information on conservation alternatives and, in addition, to prepare an analysis which would include discussion of the need for additional capacity and the alternatives to the construction of a coal-fired plant. In this regard, it is also intended to provide a base for future FEA efforts in regard to the electric power supply in the Southwestern United States. Since it is intended to provide energy background for preparation of the Environmental Impact Statement, environmental impacts of Kaiparowits and its alternatives are mentioned only in passing.

The following discussion is based on information provided by participating utilities, the BLM, the California Public Utilities Commission, the Arizona Corporation Commission, RAND Corporation, and others.

A general description of the Kaiparowits Project is presented in Section I. Section II considers electric power demand forecasts and presents rationales for the Kaiparowits Project. Section III discusses conceptual alternatives to the proposed project. Section IV concerns alternative uses of the energy resources which would be required by Kaiparowits. Conclusions are presented in Section V.

I. Introduction

The Kaiparowits Project plan provides for construction and operation of a 3,000 megawatt steam power electric generating station, associated transmission facilities, and underground coal mines. The latter would supply nine million tons of coal per year required for production of steam.

The Project is a joint venture of three utilities: Southern California Edison Company (SCE) (40% of output), San Diego Gas and Electric Company (SDG&E) (23.4%) and Arizona Public Service Company (APS) (18.0%). At present 18.6% of the output is uncommitted but has been offered to other Southwestern utilities. The power generated by Kaiparowits would be transmitted for distribution in the areas shown in Figure 1. The present schedule envisions operation of the first 750 megawatt unit in 1981, the second in 1982, and full operation of all four units by the end of 1983.

Mining and generating facilities would be located on the southern portion of the Kaiparowits Plateau in South Central Utah. The power plant site is currently under the jurisdiction of the Bureau of Land Management. The State of Utah, in exercise of its selection rights, has requested the BLM to transfer land to be occupied by the power plant to State control. The State, upon acquisition of title, would sell the land to the participatin utilities. The Kaiparowits participants have purchased coal leases on 46,000 acres of Federal and State lands in the plant's vicinty.

Each year, approximately 45,000 acre feet from Utah's allotment* of Colorado River water would be used for condenser cooling purposes when the

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*The participating utilities have contractual agreements with the State of Utah and the Department of the Interior which permits use of up to 102,000 acre feet per year for activities related to electric power generation. This amount was based upon original plans that Kaiparowits generating capacity would eventually be at a power level of 6000 Mw.

KAIPAROWITS PROJECT PARTICIPANTS
SERVICE TERRITORIES

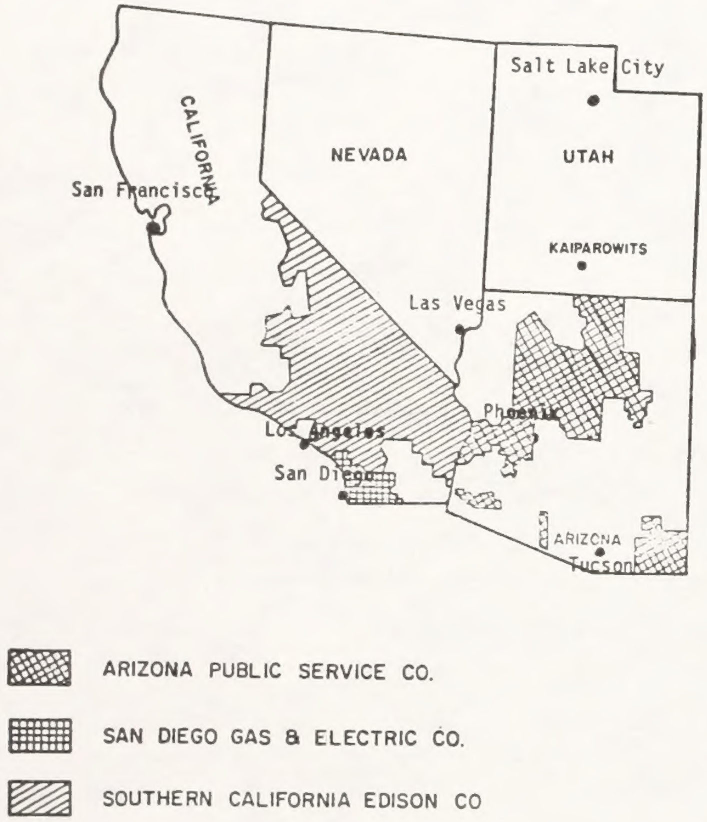

FIGURE 1

plant was operating at a 3000 Mw power level. This is the quantity of water lost through evaporation from wet cooling towers and represents approximately 2% of the total flow through the towers. In addition, approximately 7,000 acre feet per year would be required for other activities associated with the Project. The water would be pumped approximately 30 miles from Lake Powell to storage reservoirs at the plant site.

The plant is designed to meet primary and secondary air quality standards under the Clean Air Act and State Implementation Plans. However, there may be a problem in meeting the "nondegradation" standard of the Clean Air Act. Whether such a problem materializes will depend upon the outcome of environmental litigation (e.g. Sierra Club v. EPA) and possible Congressional legislative action.

The owner-companies have determined that there is a need for a power plant the size and type of Kaiparowits in order to meet projected demand for baseload capacity and to decrease utilization of oil and natural gas as a boiler fuel. If demand forecasts were to be reduced substantially, Kaiparowits would still be proposed for construction at an adjusted schedule. Because Kaiparowits output could replace power provided by presently operating oil burning plants and thus displace 80,000 barrels of oil per day, the proposed project would, even in the event of zero growth in electric power demand, reduce United States dependence upon imported oil.

II. Need for the Kaiparowits Project

The utilities' decision to undertake the project under the proposed time schedule was based on a determination by the utilities that new capacity was required in order to maintain system reliability in light of projected demand. FEA's analysis also focuses on the project independence goal of reducing oil consumption. The 3,000 megawatts of generating capacity installed at the Kaiparowits Plateau would comprise approximately 25% of the new capacity added to the combined generating capacity of these three utilities. The remainder of this section addresses (a) electric power and demand forecasts upon which the utilities base their plans for new capacity and (b) rationales for satisfying projected demand through construction of a 3,000 megawatt coal-fired generation station.

Because so many intangibles are involved in the process of forecasting electric power demand, there is wide diversity of conclusions regarding the level of future demand. As a result, demand forecasts are often disputed.

Many who believe growth in energy consumption must be slowed, maintain that utilities overestimate future demand in their forecasts, that forecasts are self-fulfilling, and therefore, more generating capacity is installed and more energy consumed than is necessary to satisfy a "reasonable" level of public need. In response, utilities contend that forecasts are not self-fulfilling that they are based on empirical and well-founded assumptions concerning growth of electric power demand.

In addition, utilities say that it is in their self-interest to make accurate demand forecasts. They point on the one hand to their responsibility to have capacity sufficient to provide adequate service, and on the other hand to the economic penalties of installing excess capacity. In rejecting the contention that demand forecasts are inflated and self-fulfilling, utilities note the difficulty of financing new facilities and the increasing costs of new generating capacity.

Nevertheless, given the fact that utility demand forecasts are contested, independent predictions of future demand would be useful in assessments of the need for new generating facilities. But no such comprehensive projections have been made for the Kaiparowits market area. Those projections which have been made either are insufficiently detailed or rest on assumptions considered too speculative as a basis for planning.* Therefore, the demand forecasts presented herein are those compiled by the Kaiparowits participants.**

While the utilities' forecasts were accepted for purposes of this report as the best available, deviations from these rates of growth might occur. Improved economic conditions, lower fuel prices, or unanticipated uses could bring about increased demand. More stringent government regulation of electric power use, higher fuel prices, or expanded conservation efforts by consumers could result in a reduced demand. Changes in the 1975 demand forecasts with respect to those made in 1973 prior to the oil embargo demonstrate the sensitivity of forecasts to events which seem speculative one year but materialize the next.***

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*California's Energy Resources Conservation and Development Commission issued a report on September 2, 1975, titled An Independent Staff Analysis of the California Public Utilities Commission's Report on Ten-Year Forecasts of Electric Utilities' Loads and Resources. This report does not provide an independent forecast.

**Primary assumptions made by each of the Kaiparowits participants in arriving at its current demand forecast and its capacity requirement are listed in Appendix A.

***In comparison to 1973 estimates, 1975 forecasts for peak demand in 1985 have been reduced approximately 34% by San Diego Gas & Electric, 23% by Southern California Edison, and 3% by Arizona Public Service. Energy conservation policies of the Kaiparowits participants are listed in Appendix A.

Forecasts and historical data are presented in the following tables and graphs.

Tables I, II and III indicate respectively for APS, SDG&E and SCE the following types of data for the years indicated.

1. Market area population
2. 1973 forecast of peak demand
3. 1975 forecast of peak demand
4. Planned generating capacity
5. Generating reserve margins
6. 1973 forecast of energy requirements
7. 1975 forecast of energy requirements
8. Kw generating capacity per capita
9. Kw hours generated per capita

Figure 2 (APS), Figure 3 (SDG&E), and Figure 4 (SCE) contain several types of data:

1. Historical peak demand through 1974
2. 1973 utility forecasts of peak demand (1975-1985)
3. 1975 utility forecasts of peak demand (1975-1985)
4. Peak demand 1975-1985 at annual growth rates ranging from 3% to 10%.

The purpose of these curves is to show what generating capacities would be required if growth rates were to differ from those now projected by the utilities.

5. Generating capacities (year and projection)

Figure 5 shows peak demand as a function of growth rate for the Kaiparowits market areas.

Figure 6 shows APS energy generated by fuel type for years 1963-1985.

Figure 7 shows SDG&E energy generated by fuel type for years 1960-1985.

Figure 8 shows SCE energy generated by fuel type for years 1960-1985.

TABLE I

ARIZONA PUBLIC SERVICE [a]

Year		Estimated Electric Service Area Population (Thousands)	1973 Forecast of Peak Demand (Megawatts)	1975 Forecast of Peak Demand (Megawatts)	Planned Gen. Capacity (Megawatts)	Generating Reserve Margin (%)	1973 Forecast Energy Requirements (10^6 kwhr)	1975 Forecast Energy Requirements 10^6 kwhr	Load Factor[b] (%)	Kilowatt Gen. Capacity Capita[b]	Kilowatt Per Capita
1955		469		359	483	34.5		1744	55.5	1.03	3719
60	HISTORICAL	578		651	836	30.6		3208	57.5	1.45	5639
65		678		817	1413	78.3		4214	58.9	2.08	6215
1970		727		1273	1655	32.3		5918	53.1	2.28	8140
71		761		1407	1698	22.2		6752	54.8	2.23	8873
72		791		1659	2085	27.5		7938	54.5	2.64	10035
73		821		1811	2191	22.8	8427	8888	56.0	2.66	10326
74		856	2042	2032	2504	25.3	10271	9672	54.3	2.93	11299
1975		896	2286	2165	2590	21.8	11272	9864	52.0	2.90	11009
76		930	2542	2394	2834	22.3	12655	11768	56.1	3.10	12654
77		967	2471	2614	3152	22.5	13588	12780	55.8	3.26	13216
78		1007	2965	2882	3420	20.3	14688	14322	56.7	3.40	14222
79		1047	3184	3134	3435	10.4	15683	15417	56.2	3.28	14752
1980		1090	3415	3364	3800	14.1	16697	16872	57.3	3.49	15479
81		1128	3653	3599	4006	12.3	17740	18350*	58.2*	3.55	16268*
82		1169	3920	3838	4570	20.6	18973	19634*	58.4*	3.91	16796*
83		1208	4197	4082	4834	19.9	20112	21155*	59.2*	4.00	17512*
84		1247		4385	5401	25.0		22672*	59.0*	4.33	18181*
85		1270		4644	5690	24.3		24001*	59.0*	4.48	18898*

Average Annual Compound Growth Rates (%)

1960-65		3.2		4.6	11.0			5.1		7.5	1.2
1965-70		1.4		9.3	3.7			7.0		1.9	5.5
1970-75		4.3		11.2	9.5			10.8		4.9	6.2
1975-80		4.0	8.4	9.2	7.9			11.3		3.8	7.0
1980-85		3.1		6.6	8.4			7.3		5.1	4.1

[a] Arizona Public buys power and energy from Salt River Project. This power and energy is included in the historical and projected figures. In Years 1955-1974, all data is historical. In years 1975-1985, all data is projected.

[b] Based on historical data for years 1955-1974 or on 1975 forecast for years 1975-1985. Margin is calculated as percent of peak demand minus SRP territorial.

*Forecast energy includes pumping energy required for Montezuma pumped storage generation.

Data and projections provided by Arizona Public Service 10/9/75.

TABLE II

SAN DIEGO GAS & ELECTRIC

Year		Population (Thousands)	1973 Forecast Of Peak Demand (Megawatts)	1975 Forecast Of Peak Demand (Megawatts)	Planned Gen. Capacity (Megawatts)	Generating Reserve Margin (1) (2) (%)	1973 Forecast Energy Requirements (10^6kwhr)	1975 Forecast Energy Requirements (10^6kwhr)	Load Factor (1) (%)	Kilowatt Gen. Capacity/ Capita (1)	Kilowatt Hrs. Per Capita (1)
1955											
60	Historical	1050		670	769	14.8		2835	48.3	0.73	2700
65		1150		900	1166	29.6		3976	50.4	1.01	3457
1970		1350		1330	1519	14.2		5967	51.2	1.13	4420
71				1495	1719	15.0		6586	50.3		
72				1610	1846	14.7		7417	52.6		
73				1495	2130	42.5	8707	7652	58.4		
74		1528	2000	1498	2036	31.5	9663	8191	58.0	1.33	5360
1975		1564	2100	1619	2236	38.1	10933	8896	65.4	1.41	5688
76		1605	2250	1646	2274	38.2	12183	9392	65.1	1.39	5852
77		1647	2500	1773	2268	27.9	13246	10133	65.2	1.39	6146
78		1690	2700	1965	2508	27.6	14358	11106	64.5	1.48	6572
79		1735	2875	2144	2622	22.3	15566	11977	63.8	1.51	6903
1980		1780	3250	2351	2622	11.5	16979	12755	61.9	1.47	7166
81		1822	3460	2473	2831	14.5	18431	13413	61.9	1.55	7362
82		1865	3790	2598	3215	23.7	20069	14101	61.9	1.72	7561
83		1909	4000	2734	3542	29.6	20800	14833	61.9	1.86	7770
84		1954	4375	2873	3705	28.9	22400	15596	61.9	1.90	7982
1985		2000	4600	3023	4123	36.4	24200	16400	61.9	2.05	8200

AVERAGE ANNUAL COMPOUND GROWTH RATES (%)

1960-65		1.8		6.1	8.7			7.0		6.7	5.1
1965-70		3.2		8.1	5.4			8.5		2.3	5.1
1970-75		3.0		5.8	8.0			9.2		4.8	6.0
1975-80		2.6	9.1	7.7	3.6			7.5		0.8	4.7
1980-85		2.4	7.2	5.2	9.3			5.2		6.9	2.7

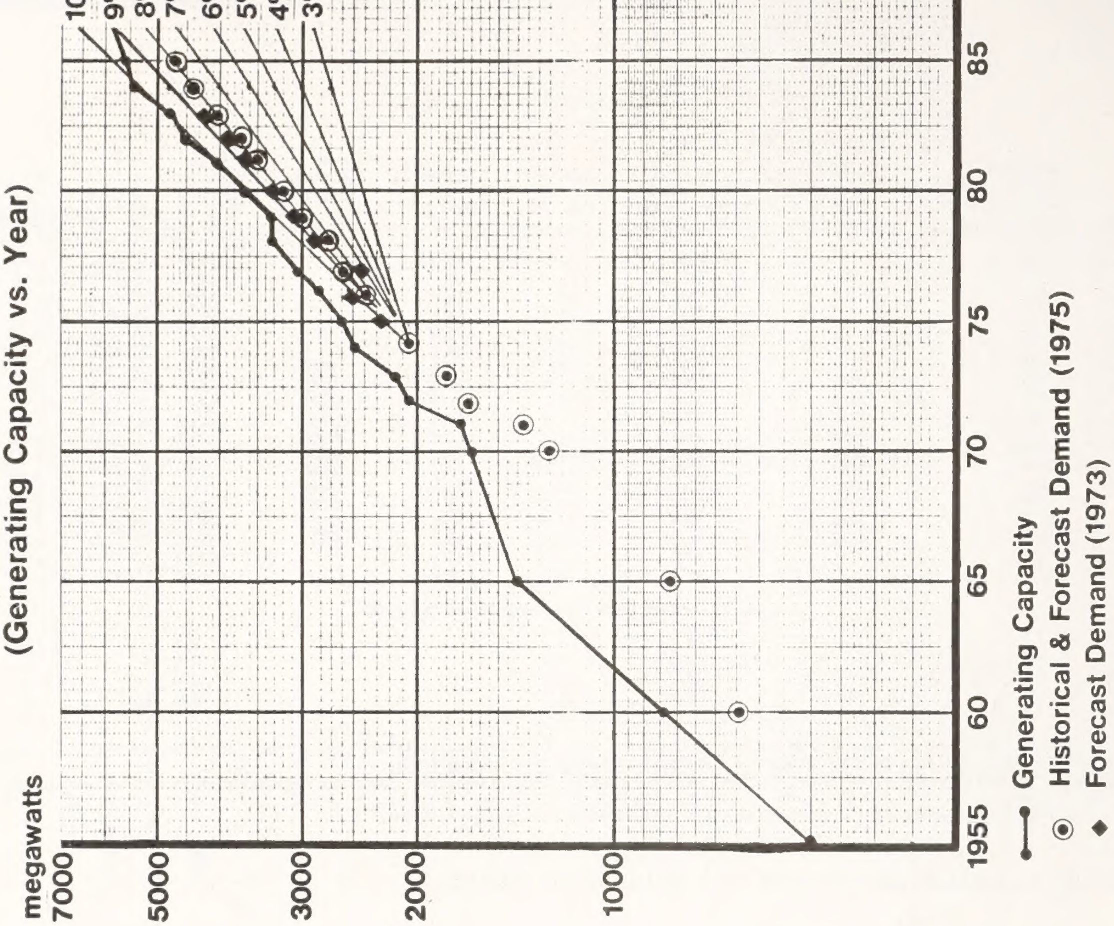
*In years 1955-1974, all data is historical. In years 1975-1985, all data is projected.

(1) Based on historical data for years 1955-1974 or on 1975 forecast for years 1975-1985.

(2) Calculated at time of peak demand, without consideration of scheduled maintenance or forced outages.

Data and projections provided by San Diego and Electric on 10/9/75.

ARIZONA PUBLIC SERVICE COMPANY
(Peak Demand vs. Year)
(Generating Capacity vs. Year)



Based on data provided by Arizona Public Service 10/9/75.

Figure 2

TABLE III

Southern California Edison Company(a)

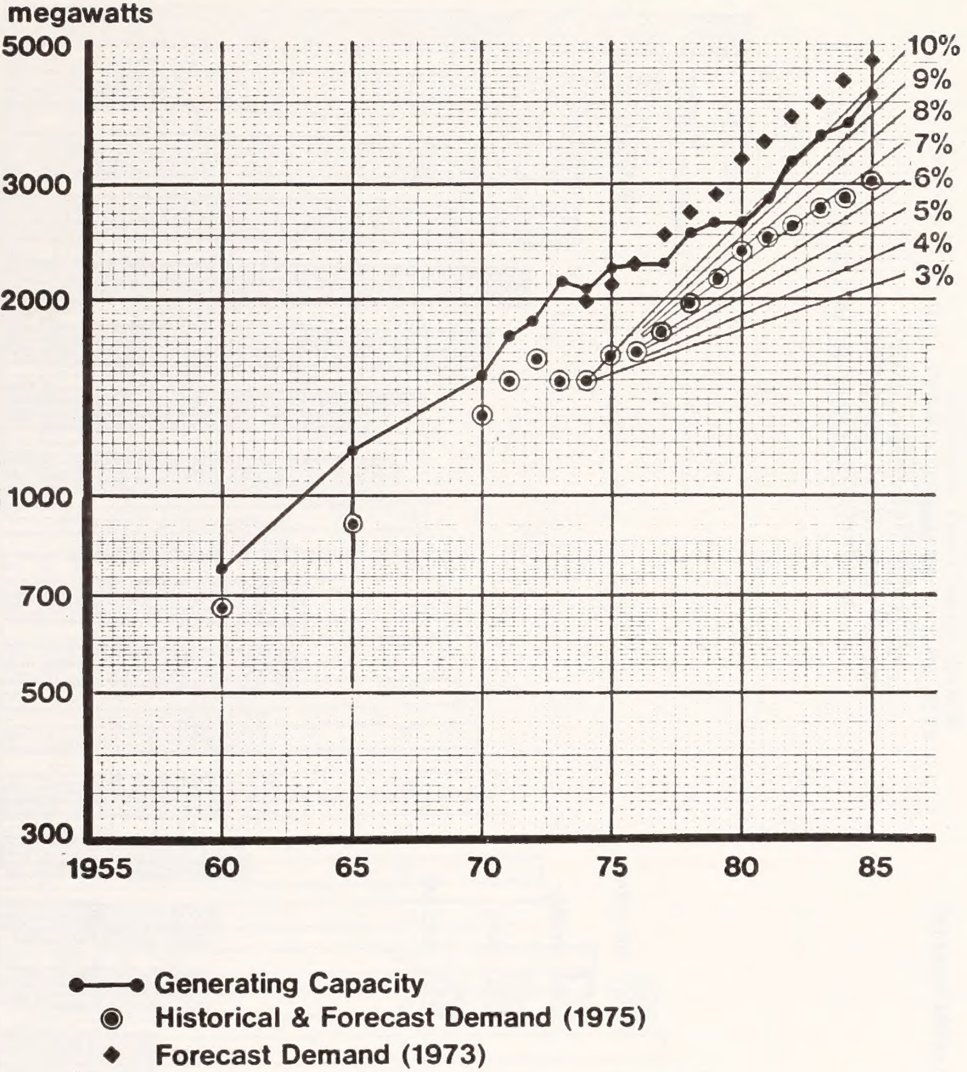
Year		Population (Thousands)	1973 Forecast Of Area(b) Peak Demand (Megawatts)	1975 Forecast Of Area(b) Peak Demand (Megawatts)	Planned Gen. Capacity(c) (Megawatts)	Generating Reserve(a) Margin(b)(c) (%)	1973 Forecast Of Area Energy Requirements(d) (10^6 kWhr)	1975 Forecast Of Area Energy Requirements(d) (10^5 kWhr)	Area Load(a)(b) Factor(c)(d) (%)	Kilowatt Gen.(c) Capacity/ Capita	Kilowatt hrs(d) Per Capitr
1955		4308		2454	2778	13.2		14228	66.2	0.65	3303
1960		5406		3972	4619	16.3		22659	65.1	0.85	4191
1965	HISTORICAL	6551		6034	7088	17.5		34919	65.1	1.08	5306
1970		7250		8556	11016	28.8		50924	67.9	1.54	7024
71		7339		9817	11483	17.0		54163	63.0	1.76	7380
72		7421		10317	12719	23.3		57295	63.4	1.74	7721
73		7506		10535	13400	27.2		59430	64.4	1.83	7918
74		7591	11365	10279	13650	32.8	64582	56605	62.9	1.80	7457
1975		7677	12217	10712	13772	28.6	69194	58194	62.0	1.79	7580
76		7766	13050	11202	13289	24.0	74295	59852	61.0	1.79	7707
77		7859	13903	11722	14411	22.9	79342	62076	60.5	1.83	7899
78		7957	14766	12287	14883	21.1	84727	65024	60.4	1.87	8172
79		8060	15689	12864	15063	17.1	90320	67922	60.3	1.87	8427
1980		8166	16683	13471	15791	17.2	96143	71080	60.2	1.93	8704
81		8275	17686	14075	16461	17.0	102177	74752	60.6	1.99	9033
82		8387	18718	14751	17822	20.8	108657	78709	60.9	2.10	9385
83		8503	19832	15542	18869	21.4	115408	[illegible]	61.0	2.22	9771
84		8623	20956	16286	19402	19.1	121955	[illegible]	61.3	2.25	10148
1985		8743	22123	17081	20022	17.2	128835	92047	61.5	2.29	10528

Average Annual Compound Growth Rates (%)

	Population	1973 Forecast Peak Demand	1975 Forecast Peak Demand	Planned Gen. Capacity	Generating Reserve Margin	1973 Forecast Energy Requirements	1975 Forecast Energy Requirements	Area Load Factor	Kilowatt Gen. Capacity/ Capita	Kilowatt hrs Per Capitr
1960-65	4.0	9.0	9.0	8.9		9.3	9.0		4.9	4.8
1965-70	2.0	6.9	6.9	9.2		8.4	7.8		7.4	5.8
1970-75	1.2	7.4	4.6	4.6		7.0	2.7		3.1	1.5
1975-80	1.2	6.4	4.7	2.8		6.8	4.1		1.5	2.8
1980-85	1.4	5.8	4.9	4.9		6.0	5.3		3.5	3.9

(a) Based on historical data in years 1955-1974 and on 1975 forecast for years 1975-1985.
(b) Area demand = Edison's net main system demand, total MWD demand and other contractual obligations.
(c) At time of area peak demand.
(d) Area energy requirements = Edison net main system, total MWD transmitted, and other contractual obligations.

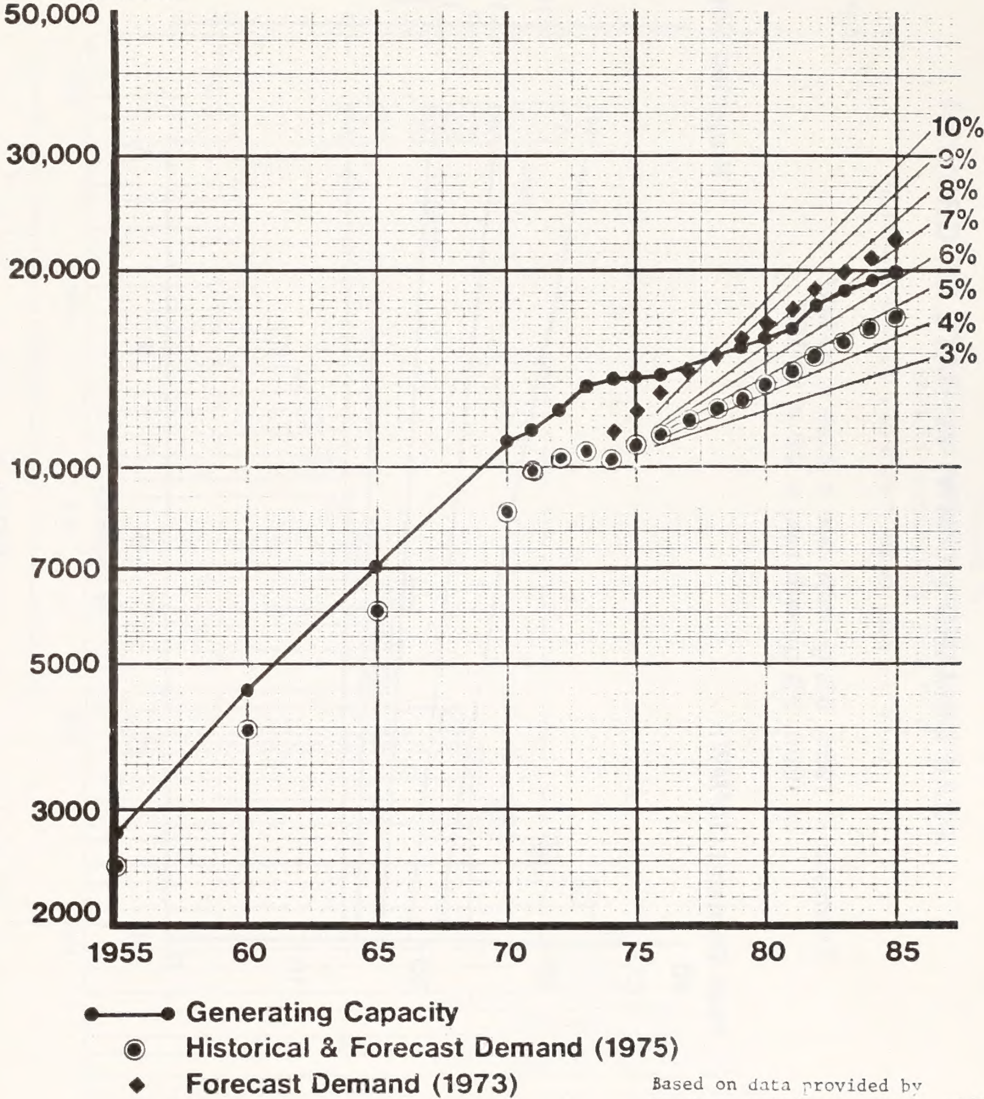
Data and projections provided by Southern California Edison 10/9/75.


SAN DIEGO GAS & ELECTRIC
(Peak Demand vs. Year)
(Generating Capacity vs. Year)

Based on data provided by San Diego Gas and Electric 10/9/75

Figure 3

II-9


SOUTHERN CALIFORNIA EDISON
(Peak Demand vs. Year)
(Generating Capacity vs. Year)

Based on data provided by
Southern California Edison 10/9

Figure 4

II-10

PEAK DEMAND (10^3MW) vs. RATE OF GROWTH

(in Kaiparowits Market for Various Years as Specified)

Example: In 1985, 5% growth rate = 23.6 × 10^3MW
In 1985, 7% growth rate = 29 × 10^3MW

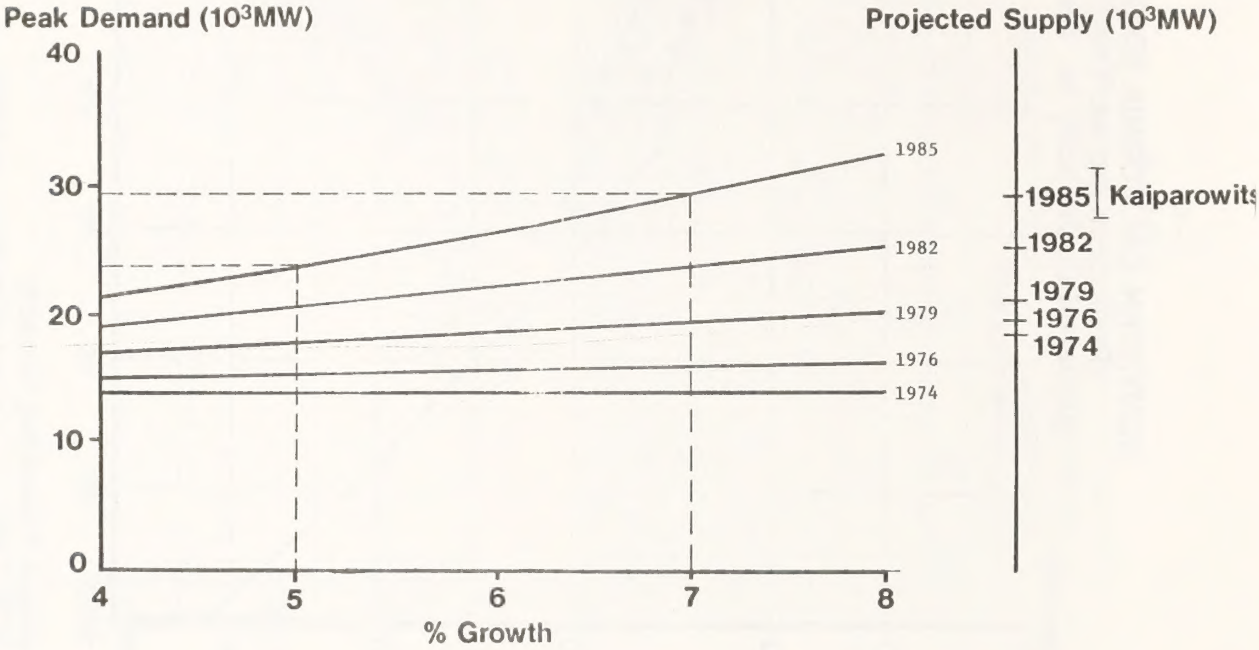


FIGURE 5

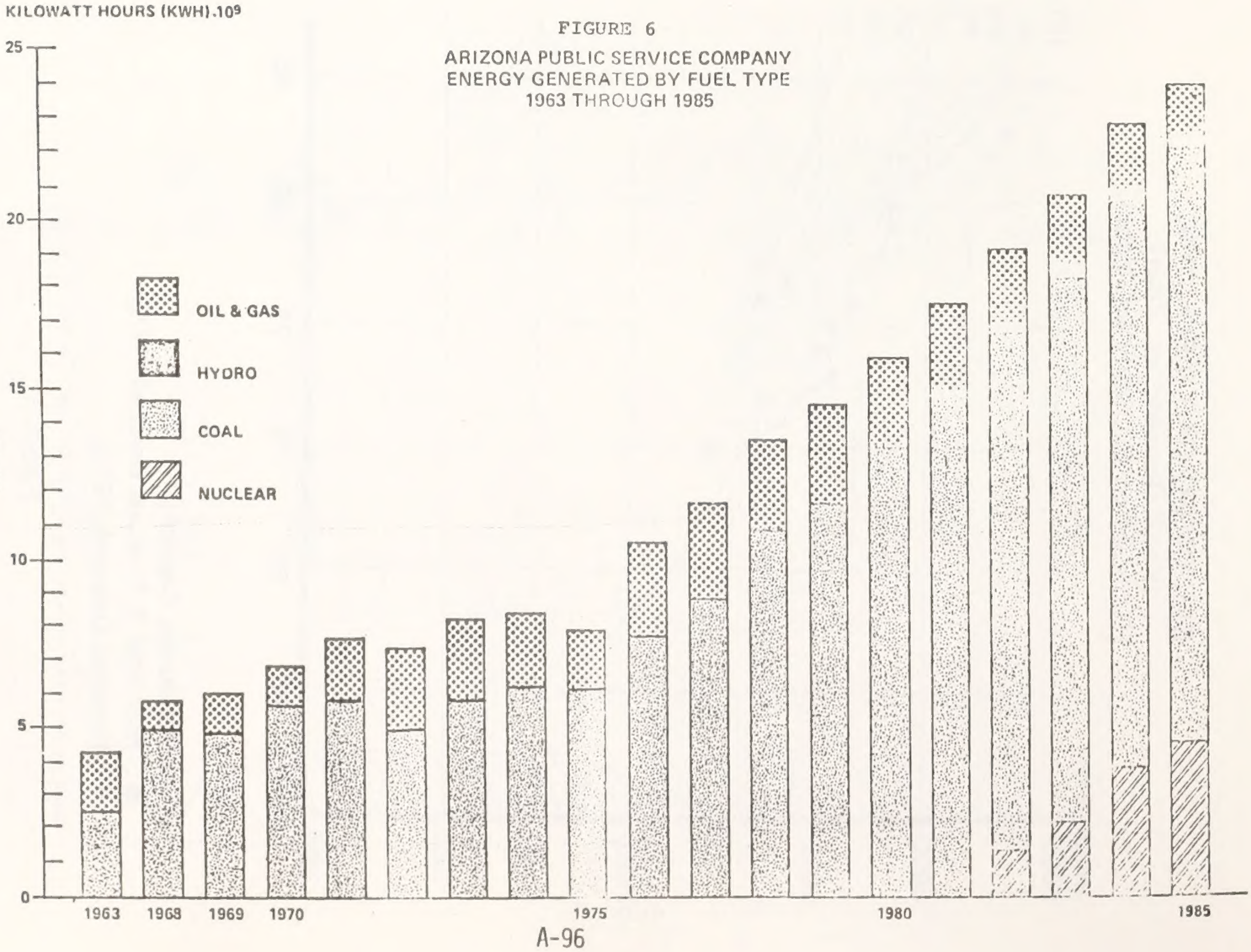


FIGURE 6
ARIZONA PUBLIC SERVICE COMPANY
ENERGY GENERATED BY FUEL TYPE
1963 THROUGH 1985

FIGURE 7
SAN DIEGO GAS AND ELECTRIC COMPANY
ENERGY GENERATED BY FUEL TYPE
1960 THROUGH 1985

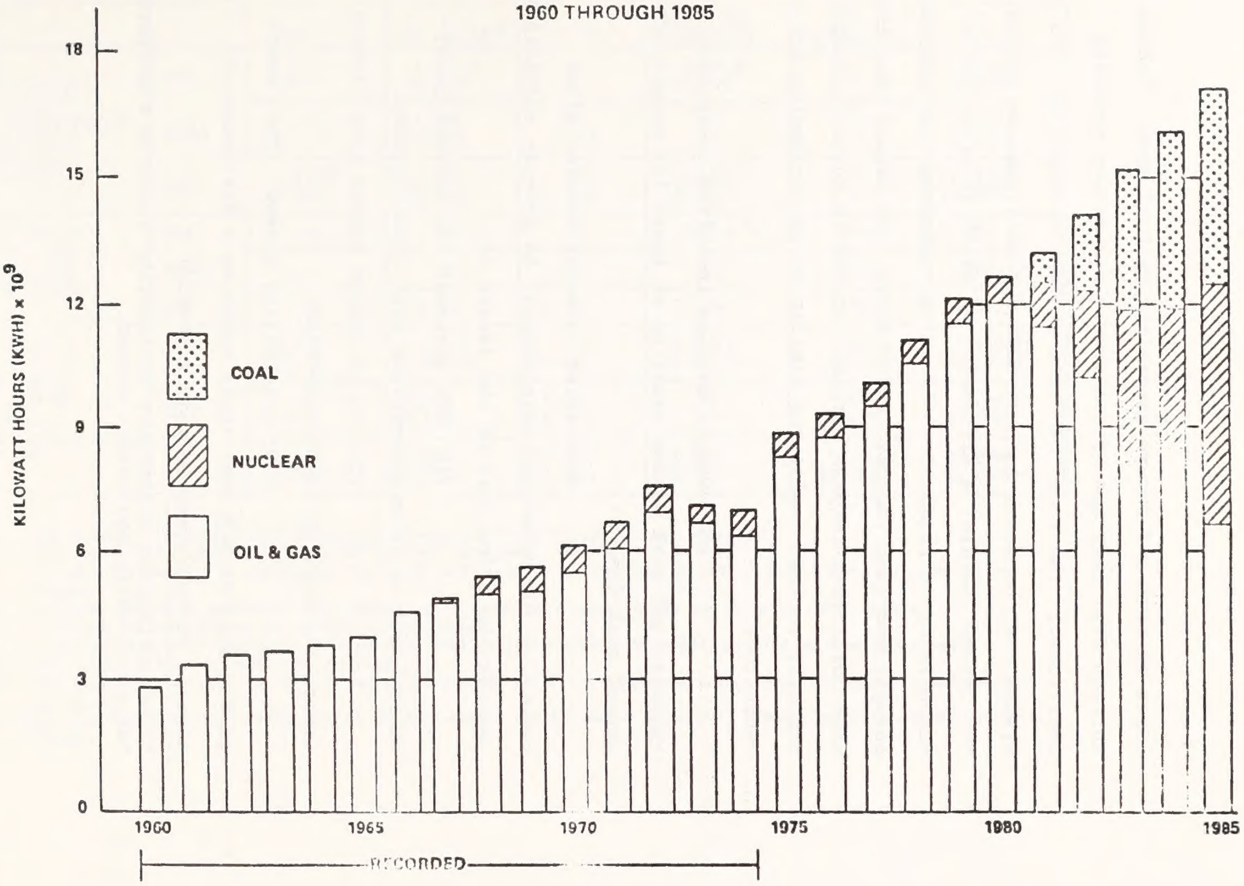
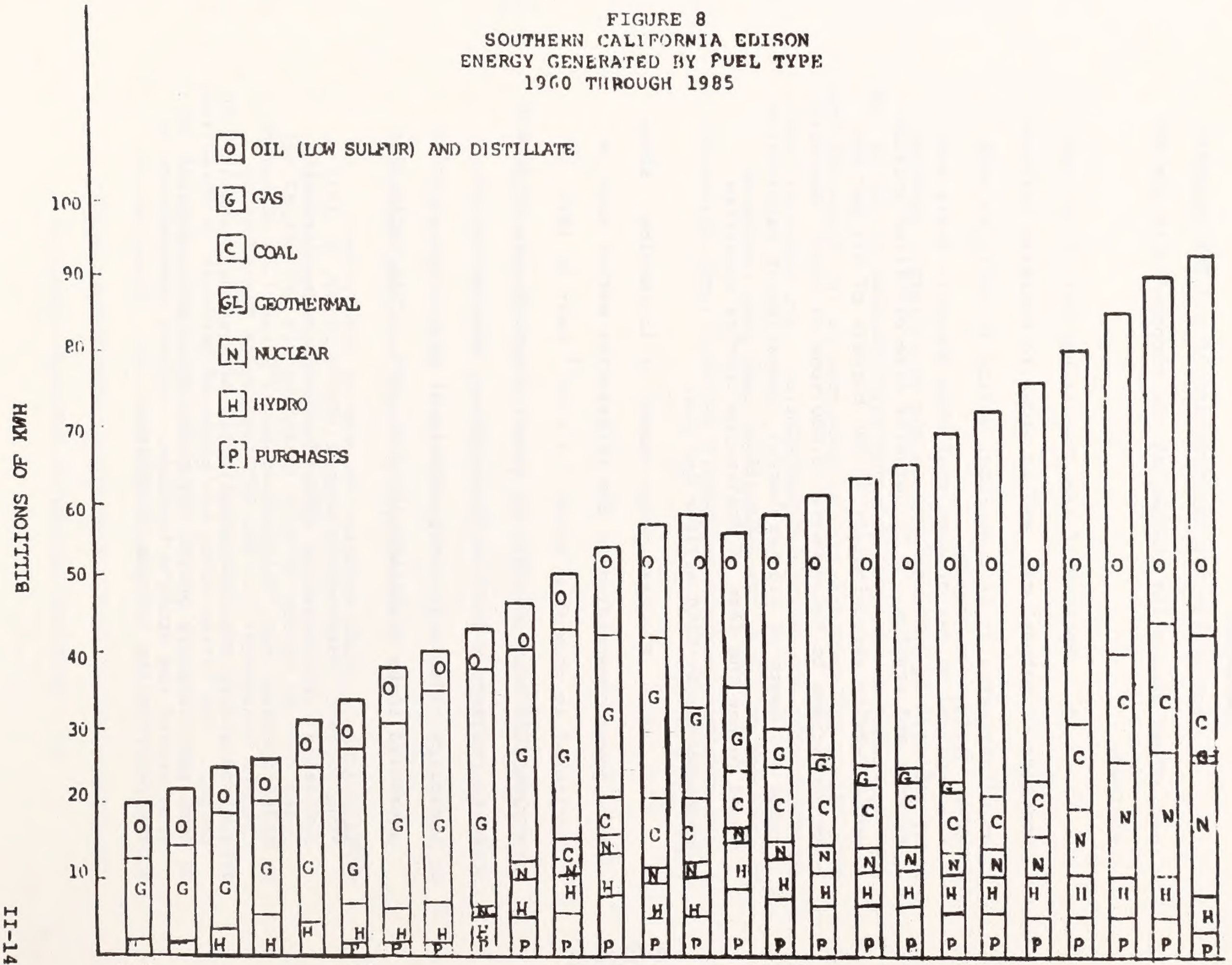


FIGURE 8
SOUTHERN CALIFORNIA EDISON
ENERGY GENERATED BY FUEL TYPE
1960 THROUGH 1985



B. Discussion

Rationales for construction of a 3,000 megawatt coal-fired generating station at the proposed site are as follows:

1. Because of the increasing cost of oil and scarcity of natural gas, and in order to decrease reliance on oil imports, it is a National policy to shift as much as practical to use of more available domestic fuels such as coal and uranium. A Kaiparowits size oil-fired station would require approximately 80,000 barrels of oil per day in comparison to Kaiparowits' 25,000 tons of coal. Assuming crude oil costs of $13 per barrel, operation of Kaiparowits could reduce the flow of dollars to foreign countries respectively by $380 million per year.

2. Electric power demand is increasing. Electric power consumption in the Kaiparowits market area is projected to grow from about 7.4 x 10^{10} kwhr in 1974, to 13.2 x 10^{10} kwhr in 1985, an annual compound rate of growth of approximately 5.4%*. This requires new generating capacity. (Table IV lists additional generating capacity scheduled to be available prior to 1985. This table also

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*The Project Independence Report (Table II-24, p. 127; indicates for the period 1973-85 compound annual growth rates for the Nation of 6.3% (assuming $11 per barrel oil (1973 dollars) and "business-as-usual") and 7.4% (assuming "Demand Management"). The 1973 Southwest Energy Study assumed a 7.6% compound annual rate of growth in the 1970-80 period. The latter study was prepared pursuant to directions from the Secretary of the Interior who neither approved nor disapproved the Study's findings. Project Independence is currently in the process of update.

lists current and future generation by fuel type. Tables V through VII list specific electric generation capacity additions.) The level of total generating capacity in a system must be equal to peak demand plus a reserve margin. The reserve margin, a discussion of which is presented in Appendix C, is required to allow for scheduled and unscheduled outages and load forecast uncertainty. To insure that they have sufficient reserve margins, utilities install enough capacity so that conditions similar to the following are satisfied:

a. Margin between installed generating capacity and peak demand equal to at least 15% to 25% of annual peak demand.

b. Generating capacity margin, after deducting for scheduled maintenance, to provide sufficient capacity to allow loss of the larger of:

(1) The systems' two largest generating units or interconnections with other systems.

(2) 7% of system demand plus largest generating unit or interconnection.

c. 0.95 reliability index. (This means in the case of SCE that there would be a 95% chance of meeting demand every hour in a year.*)

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*Other utilities define the reliability index in a different, but essentially equivalent manner.

TABLE I/

GENERATING CAPACITY /MW/ ([illegible]RGY /10^6 KWHR/)

		HYDRO	OIL AND GAS[a]	NUCLEAR	COAL LESS KAIPAROWITS	COAL KAIPAROWITS	TOTAL
Capacity-12/31/74 (Energy Genera Generated During 1973)	APS	4.9 (36)	1,101.7 (2,242)	— —	1,036.8 (5,914)	-- --	2,503.7 (9,672)
	SDG&E	-- --	1,988 (6,629)	86 (453)	-- --	-- --	2,074 (7,253)
	SCE	1,310[c] (6,356)	9,352 (30,470)	344 (2,496)	1,653 (8,505)	-- --	13,539[d] (56,605)
Scheduled Additions of Capacity 1975-1985	APS	225	255	714	1405.5	540	3186.1[e]
	SDG&E	--	452	915	--	702	2,069
	SCE	29	3,126	2,140	-56	1,164	6,367[f]
Capacity 12/31/85 (Energy Generated During 1985)	APS	229.9 (461.0)	1,356.7 (1,468.3)	714 (4.557)	2,442.3 14,721.7)	540 (2,773.9)	5,689.8[g] (24,001)[h]
	SD&E	-- --	2,440 (6,618)	1,001 (5,815)	-- --	702 (4,625)	4.43 (17,058)
	SCE	1,339 (6,088)	12,478 (50,666)	2,484 (17,659)	1,597 (9,153)	1,164 (7,584)	19,904[c] (92,047)

a/ 1974 capacity includes 127.5 MW coal purchases and 232.8 MW gas and oil purchases.
b/ 1974 energy total includes 1480 x 10^6 kwh net purchases.
c/ Includes 277 mw of firm purchases, 310 mw of mwd capacity and reduced by 119 mw due to adverse winter hydro
d/ derate
d/ Includes 980 mw of purchases and reduced by 71 mw of off-system losses and 29 mw of hydro derate.
e/ Additions include 46.6 mw net additional purchases.
f/ Includes - 370 mw of purchases, 234 mw from fuel cells installed 1981-1985, and 100 mw from geothermal.
g/ 1985 capacity includes 406.9 mw purchases.
h/ 1985 total includes 19.1 x 10^6 kwh net sales and 609 x 10^6 kwh pump-back energy from Montezuma pumped storage generation.
i/ Includes 234 mw of fuel cells, 100 mw of geothermal, and 565 mw of purchases, reduced by 55 mw of off-system losses.

3. Baseload generating capacity should be increased in order to minimize system operations' costs. (Characteristics of baseload generation are: operation at or near full capacity during all hours that the generating unit is available and low energy costs per kilowatt hour of generation.)*

4. Economies of scale can be achieved through construction of large electric generating facilities.

5. The proposed site has been selected because of proximity of extensive coal reserves, inability of a Southern California area coal-fired plant to meet air emission standards, and scarcity of water in the Phoenix area.

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* For example, Southern California Edison's (SCE) objective is that 40% to 50% of its capacity be base load resources (nuclear, coal and certain hydroelectric). SCE contends that only 16% of its capacity will be base load in the 1975-1980 period, but expects base load capacity will increase to 29% of its total capacity of approximately 19,402 MW in 1985. (Source: Southern California Edison)

TABLE V

ARIZONA PUBLIC SERVICE COMPANY
GENERATION RESOURCE ADDITIONS
(Through 1986)

Year of Installation	Resource	Net Capacity (MW)
1976	Combined Cycle	246
1976	Navajo Unit 3 (750 MW) (a)	105
1977, 1978	Cholla Units 2,3 (500 MW)	500
1980	Cholla Unit 4 (350 MW)	350
1981, 1982, 1983	Kaiparowits Units 1, 2, 3, 4 (3000 MW) (b)	540
1981, 1982, 1983	Montezuma Pumped Storage (500 MW)	225
1982, 1984, 1986	Arizona Nuclear (3810 MW) (c)	1071

a Units shared by U. S. Bureau of Reclamation, Salt River Project, Tucson Gas & Electric Company, Department of Water and Power of the City of Los Angeles, Nevada Power Company, and Arizona Public Service Company.

b Units shared by San Diego Gas & Electric Company, Southern California Edison Company and Arizona Public Service Company.

c Arizona Public Service Company, with other utilities, including Southern California Edison is planning to construct a nuclear generating station. The planned service date is 1982, if there are no extended delays in the permit or construction stages.

TABLE VI

SAN DIEGO GAS & ELECTRIC COMPANY
GENERATION RESOURCE ADDITION PLAN
1975-1985

Planned Commercial Operating Date	Station and Unit	Type	Capability (1) (MW-Net)
Scheduled Units (5)			
May 1975	Naval Station	Gas Turbines	32
Mar 1978	Encina 5	Steam	292
Jun 1979	South Bay GT 2	Gas Turbine	64
Jun 1979	South Bay GT 3	Gas Turbine	64
Oct 1980	San Onofre 2 (Initial)	Nuclear	44 (2)
Oct 1981	San Onofre 2	Nuclear	176 (2)
Jan 1982	San Onofre 3 (Initial)	Nuclear	44 (2)
Jan 1983	San Onofre 3	Nuclear	176 (2)
Planned Units (5)			
Jun 1981	Kaiparowits 1	Steam-Coal	176 (3)
Jun Jun 1982	Kaiparowits 2	Steam-Coal	175 (3)
Mar 1983	Kaiparowits 3	Steam-Coal	176 (3)
Dec 1983	Kaiparowits 4	Steam-Coal	175 (3)
May 1985	Sundesert 1	Nuclear	475 (4)

(1) Dependable winter capability. Summer capabilities of gas turbines are lower.
(2) 20% share of 1100 MW units with 20% firm capacity available between initial power operation and commercial operation.
(3) 23.4% share of 750 MW units.
(4) 50% share of 950 MW units.
(5) Scheduled units are those for which application has been submitted to the California Public Utilities Commission for a Certificate of Public Convenience and Necessity. Planned units are all others.

TABLE VII

Southern California Edison Company
Generation Resource Additions
(1975-1985)

Date	Resource	Net Capacity Added to SCE (MW) (a)
	Coal-Fired Generation	
1975-77	Rerate Four Corners 4 & 5	-56
1981-83	Kaiparowits 1-4	1164(b)
	Nuclear Generation	
1980-83	San Onofre 2 & 3	1760(c)
1982-85	Palo Verde 1-2	380(d)
	Geothermal Generation	
1985	Geothermal 1 & 2	100
	Combined-Cycle Generation, Fossil Fueled	
1976	Long Beach 1-7	572
1978	Coolwater 3 & 4	472
1980-85	Lucerne Valley 1-3	1290
	Oil and Gas Fired Genration	
1979	Yuma Axis	25
1979	Rerate Long Beach 10 & 11	112
	Peaking Generation	
1979	Axis Combustion Turbine	25
1981-85	Fuel Cells 1-9	234
1980	Big Creek Area Development (hydro)	29
1981	Combustion Turbine	60
1985	Combustion Turbine	570
	Purchased Power	
1975	Navajo 2 Layoff (terminates in 1985)	101
1975	Portland General Electric Exchange (seasonal)	94
1976	Navajo 3 Layoff (terminates in 1985)	123
1979	Edwards AFB Exchange (terminates in 1986)	18(e)
	Retirements and Terminations	
1980-85	Navajo Layoff	-319
1985	Oroville-Thermalito	-309(f)

(a) Huntington Beach Combined Cycle is an alternative to capacity shown in the 1980-1985 time frame.

(b) Allocation of Kaiparowits Project power to each participant has not been finalized; however an Edison share of 40 percent is assumed. (Includes 3% transmission loss)

(c) 80 percent share of two 1,100 MW units.

(d) 15.4 percent share of two 1270 MW units less 3% transmission loss

(e) Edwards AFB Exchange has a winter capacity of 15 MW.

(f) 319 MW of capacity reduced by 10 MW for summer adverse hydro derate, and 29 MW for winter adverse hydro derate.

III. Conceptual Alternatives to the Proposed Kaiparowits Project

This section considers how electric power needs might be satisfied in the Kaiparowits market area by various alternatives to the proposed project. The following section discusses uses for other than electric power generation of energy and water resources which would be preempted by Kaiparowits as now planned. Alternatives addressed in this section include: delay or cancellation of the project; purchase of power from other systems; construction of other types of generating facilities at different sites; and investment in energy conservation. Alternatives not analyzed in detail include those which would clearly not be economically viable in the early or mid 1980's; e.g., fusion. Also not discussed are public policy options (e.g., redesign of electric power rate structures or mandatory conservation) which would have widespread impact on energy matters and, in so doing, might affect the need for Kaiparowits and/or the merits of its alternatives.*

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*For example, financial incentives and disincentives combined with regulations concerning electric power use could limit electric power demand to the point where new generating capacity would not be required. In such circumstances a decision as to whether or not to proceed with Kaiparowits would depend upon considerations of how best to use Kaiparowits coal. Discussion of the costs and benefits of public policies aimed at restricting electric power demand is beyond the scope of this report.

A consideration of the alternatives to Kaiparowits gives some idea of possible tradeoffs between economic, resource and environmental factors characteristic of the various options. The focus of the following discussion is on the economic viability and resource requirements of Kaiparowits alternatives. Environmental impacts of alternatives are mentioned here and addressed directly in the Kaiparowits Environmental Impact Statement.

A. Deferral in Consequence of Reduced Demand

Rising prices and government actions (e.g., rate restructuring or mandatory conservation) could reduce the rate of growth of demand for electric power. The date at which Kaiparowits generating capacity would be required would thereby be postponed.

Delay might allow time for substantial refinements in the scrubber technology. Delay might also allow development of environmentally preferable generating technologies making them economically feasible and removing the need for coal-fired plants such as Kaiparowits.* However, the utilities believe such technological improvements are not likely to become economic in the near future. Therefore, unless the demand growth rate is far less than is now projected, new technologies could not be substituted for the proposed project as planned. Moreover, as noted above, Kaiparowits could replace 3,000 megawatts of oil-fired generating capacity (i.e., 80,000 barrels per day) and might therefore be justified even in the event of zero growth.

In the event that Kaiparowits was deferred and growth in demand did occur in accordance with utilities' estimates reserve generating capacity would fall below what is considered necessary to provide adequate system reliability. Table VIII indicates forecast reserve margins in the event the Kaiparowits schedule was delayed. Table VIII assumes that demand will approximate the utilities' current forecasts (ref. tables I, II & III).

Table VIII

RESERVE MARGINS*

APS (18% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
81	12.3	8.2	8.2	8.2
82	20.6	16.8	13.0	13.0
83	19.9	16.4	12.8	9.2
84	25.0	21.7	18.4	15.0
85	24.3	24.3	21.2	17.6

*Margins as percent of APS load forecast minus Salt River Project territorial.

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*A third potential benefit of delay would be additional time for regional planning. This could, in principle lead to lesser adverse impacts than are implicit in the present project plan. However, because Kaiparowits has received considerable analysis in the Southwest Energy Study, it is not likely that additional regional study would affect conclusions regarding the location of the Kaiparowits Project even though such study might have a large impact upon decisions concerning the location of subsequent projects.

SDG&E (23.4% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
81	14.5%	7.4%	7.4%	7.4%
82	23.7%	17.0%	10.2%	10.2%
83	29.6%	23.1%	16.7%	10.3%
84	28.9%	22.8%	16.7%	10.6%
85	36.4%	36.4%	30.6%	24.8%

SCE (40% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay(a)	2 Yr. Delay(a)	3 Yr. Delay(a)
81	17.0%	14.9%	14.9%	14.9%
82	20.8%	18.8%	16.9%	16.9%
83	21.4%	19.5%	17.7%	15.8%
84	19.1%	17.3%	15.6%	13.8%
85	17.2%	17.2%	15.5%	13.8%

(a) Assumes all units are delayed from their scheduled operating dates.

As is indicated in Item 1, Section II-B and in Appendix C, reserve margins calculated on the basis of the differential between generating capacity and peak demand are used in the determination of system reliability. In addition, the nominal 15% reserve margin is a partial indication that a system has adequate reserves. Table VIII suggests that delays in Kaiparowitz would aggravate the

ability of two of three utilities in maintaining a nominal 15% reserve margin:

- APS projected reserve margin would drop below 15% in 1981 for a delay of one year or more, and in 1982 and 1983 by a delay of two or more years.
- SDG&E projected reserve margin would drop below 15% in 1981 for a delay of one or more years; in 1982 by a delay of two or more years; and in 1983 and 1984 by a delay of three or more years.
- SCE projected reserve margin would only be adversely affected by a three or more year slippage in 1984 and 1985.

The ability of the utilities to maintain a nominal 15% reserve margin could be further aggravated by delays in other planned projects. Therefore, any delay of the Kaiparowits Project would, in the view of the utilities, lead to insufficient reserve margin to provide adequate system reliability.*

B. Purchase of Power from Outside Kaiparowits Market Area

Assuming the required transmission facilities would be available, the potential for this depends on the realization of one of two possibilities: (a) that utilities outside the Kaiparowits area have unexpected surpluses or (b) that such utilities will add capacity for the express purpose of providing power to the Kaiparowits market area.

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*See discussion in Section II, p. 16; and in Appendix C.

Neither possibility is likely, for two reasons. First, all utilities are facing problems in siting generating facilities to serve their own needs; therefore, they would not exploit available sites in order to satisfy needs of other systems. Second, all utilities are faced with severe problems in financing their own facilities; again, it is exceedingly unlikely that they would draw from limited capital resources to finance facilities to help satisfy electric power demand in neighboring systems.

If purchased power were to substitute for Kaiparowits, it would be necessary for the planning of the project which would supply that power to have already progressed at least as far as Kaiparowits. No such project has been identified.

C. Coal-fired Facility at Site Within or Closer to Arizona and California Market Areas

Kaiparowits coal could be transported to coal-fired electric generating plants within Southern California and Arizona market areas. Advantages of this alternative include the avoidance of possible air pollution problems on the Kaiparowits Plateau and neighboring national parks

and the freeing of 45,000 acre feet of Utah's allocation of Colorado River water for other uses. (Possible alternative uses for this 45,000 acre feet are listed in Section IV.)

Transport of coal to market areas in Southern California and Arizona would be via train or slurry pipeline.* Table IX includes data which allow an approximate comparison of the cost of transporting electric power with the cost of transporting coal. While variances in these estimates are substantial, the data suggest that transportation costs per se would not dictate against construction of coal burning electric generating stations in market areas instead of on the Kaiparowits Plateau. Since such stations would cause impermissable air quality degradation in Southern California this alternative is not viable. Moreover, such facilities would make demands on water which is even more scarce in Southern California and Arizona market areas than in Southern Utah.

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*Since the agreement which permits use of Utah's allotment of Colorado River water requires that the water be used for purposes of electric power generation, the agreement would have to be renegotiated if the water were to be used for coal slurry purposes. In comparison to the 45,000 acre feet required for condensor cooling, a slurry pipeline to serve a Kaiparowits size facility would require approximately 6,500 acre feet per year.

Table IX

Relative Cost of Transportation
to Market Areas (Mills/kwh)

	Rail (Unit Train)	Slurry Pipeline	Electric Transmission
Kaiparowits to Southern California 1/	7.0 2/ 3.8 6/	(2.0-6.0) 6/	3.5 2/ (4.2-8.4) 6/
Kaiparowits to Phoenix, Ariz. 4/ 5/	10.0 3/ 6.0 6/	(1.2-3.6) 6/ 7/	2.0 3/ (2.4-4.9) 6/

1/ Rail and transmission line distance to Southern California approximately 500 miles.
2/ Based on Southern California Edison data.
3/ Extrapolated from Southern California Edison data.
4/ Rail distance to Phoenix approximately 800 miles; 500 miles longer than direct route because of lack of Colorado River crossings.
5/ Transmission line distance to Phoenix area approximately 300 miles.
6/ Extrapolated from 1972 Southwest Energy Study; assumes 20% increase over the Study's 1972 cost estimates.
7/ Assumes slurry pipeline routed over Glen Canyon Dam.

It is also possible to consider the alternative of using Kaiparowits coal in generating stations at sites which are neither on the Kaiparowits Plateau nor in the market areas of the owner utilities. The purpose of such siting would be to avoid the environmental impacts associated with a plant in either Southern Utah or market areas in Southern California or Arizona. In this case transport of Kaiparowits coal would be by slurry pipeline or by unit train to a site in Nevada or Eastern California. An example of such a site would be one in the vicinity of the existing 1500 megawatt coal-fired generating station, Mohave, located on the Colorado River approximately three miles south of Davis Dam.

Table X indicates differential costs between (a) the transport of coal to Mohave and electric power to market areas and (b) transport of electric power from Kaiparowits to California market areas. This table indicates that for power to be transported to Southern California there is a savings in electric power transmission and an added cost of transport for coal.* Owing to the substantial spread in estimates of transportation cost differentials, no firm conclusion can be reached regarding the magnitude of the cost penalty (or even whether there would be one) incurred by virtue of transporting Kaiparowits coal some hundreds of miles to a generating station.

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*For Arizona market areas (e.g., Phoenix) the savings resulting from less electric power transmission costs would, for two reasons, be less than for the case of California markets. First, the distance to Arizona markets is shorter and therefore power transmission costs are less. Second, Mohave is on the route from Kaiparowits to Southern California so that the total distance traveled by coal plus electric power is approximately the same as that traveled by electric power in the case of generation on the Kaiparowits Plateau. On the other hand, Mohave is not on the shortest route between Kaiparowits and Phoenix, and therefore the total distance traveled by coal plus electric power to Phoenix, is greater than would be the case for electric power generated at Kaiparowits and transmitted to Phoenix.

Table X

Differential cost between (a) Transport of coal by either train or slurry pipeline from Kaiparowits to Mohave and electric power from Mohave to Southern California, and (b) Transport of electric power from Kaiparowits Plateau to Southern California (1974 est.).

	Annual Total[1] ($ Millions)	(Mills/kwh)
Cost of Rail Transport of Coal[2]	107	5.1[3]
Cost of Slurry Pipeline Transport of Coal[2]		1.3 to 4.0[4]
Savings on Electric Power Transmission Costs	36	1.7[3];3.0 to 5.0[4]
Net Increment in Cost of Delivery of Power to Market (Rail plus electric **vis-a-vis electric)**	71	+0.1 to +3.4
Net Increment in Cost of Delivery of Power to Market (Slurry plus electric vis-a-vis electric)		-3.7 to +2.3

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[1] Southern California Edison data.

[2] Assumes Kaiparowits-Mohave distance approximately 350 miles.

[3] Extrapolated from Southern California Edison data.

[4] Extrapolated from 1972 Southwest Energy Study; assumes 20% increase over Study's 1972 cost estimates.

However, whatever the cost differential is, it is likely to be overshadowed, in deliberations of where to locate the plant, by considerations relating to water availability, environmental effects, and socioeconomic factors involving the region in which the plant would be built.

D. Oil and Gas-Fired Generating Facilities

It is now recognized that the use of oil or gas for generation of baseload electric power represents a relatively inefficient use of those resources. For this reason, new facilities fueled by either natural gas or oil are not realistic alternatives to Kaiparowits.

However, mention should be made of several hybrid possibilities which involve coal gasification or liquefaction facilities.

Costs of electric power in 1974 dollars at the point of entry into a Southern California distribution system have been estimated for various gasification, liquefaction, and transportation options. These estimates must necessarily be tentative because gasification or liquefaction facilities on the magnitude of Kaiparowits have not yet been constructed. Figure 9 and Table XI following it provide an indication of comparative costs and energy efficiencies of the following.[1]

Option A. Electric power generation (coal plus scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.

Option B. Electric power generation (low Btu gas from coal, no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2,3]

Option C. Electric power generation (high Btu gas from coal, no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2]

Option D. Electric power generation (liquefied coal, no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2]

Option E. Conversion of coal to high Btu gas at the Kaiparowits Plateau plus 500 miles transport of gas by pipeline plus electric power generation in Southern California.

Option F. Conversion of coal to low Btu gas at the Kaiparowits Plateau plus 500 miles transport of gas by pipeline plus electric power generation in Southern California.[3]

Option G. Conversion of coal to liquid at the Kaiparowits Plateau plus 500 miles transport of liquid plus electric power generation in Southern California.

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[1] These options do not include gasification or liquefaction of Kaiparowits coal for purposes other than generation of electric power. Such options are discussed in Section IV; they are not considered as alternatives to Kaiparowits because coal is abundant and its use for electric power generation does not compete with use of gasification or liquefaction.

[2] Options B, C and D would be selected only if gasification or liquefaction were an economic means of meeting air emission standards.

[3] Low Btu gas could, if used in a combined cycle generation system (i.e. gas turbine plus conventional boiler heated by turbine exhaust gases), lead to generation efficiencies upwards of 50% in comparison with Kaiparowits' 38%. However, the technology permitting achievement of such high generating efficiencies at the 3000 megawatt level will not be available for a plant being built during the years in which Kaiparowits is scheduled for construction.

Figure 9 contains the following assumptions:

Fixed costs (interest, depreciation, taxes, etc.) associated with generation, liquefaction, and gasification facilities are 20% of investment in plant.*

Operating, maintenance and administrative costs (exclusive of fuel) associated with generation, liquefaction, and gasification facilities are 10% of investment.

Cost of coal delivered to coal-fired generating station on the Kaiparowits Plateau is $15/ton, $0.66 per 10^6 Btu (22.6 x 10^6 Btu/ton).

Investment cost for coal-fired generation station on the Kaiparowits Plateau if $400 per kilowatt of generating capacity.

Investment cost for gasified or liquefied coal-fired generating facility is $300 per kilowatt of generating capacity.

Investment cost for low Btu coal gasification facility is $600 per 10^6 Btu per day production capacity.**

Gasification and liquefaction plants operate 75% of the time.

Cost of transporting 10^6 Btu of high Btu gas 500 miles is $0.10.

Cost of transporting 10^6 Btu of low Btu gas 500 miles is $0.30.

Cost of transporting 1 kwhr (3423 Btu) of electric power 500 miles is $0.004.

Electric generating efficiency is 38%.

Efficiency of converting coal to low Btu gas is 75%.

Efficiency of converting coal to high Btu gas is 60%.

Efficiency of converting coal to liquid is 70%.

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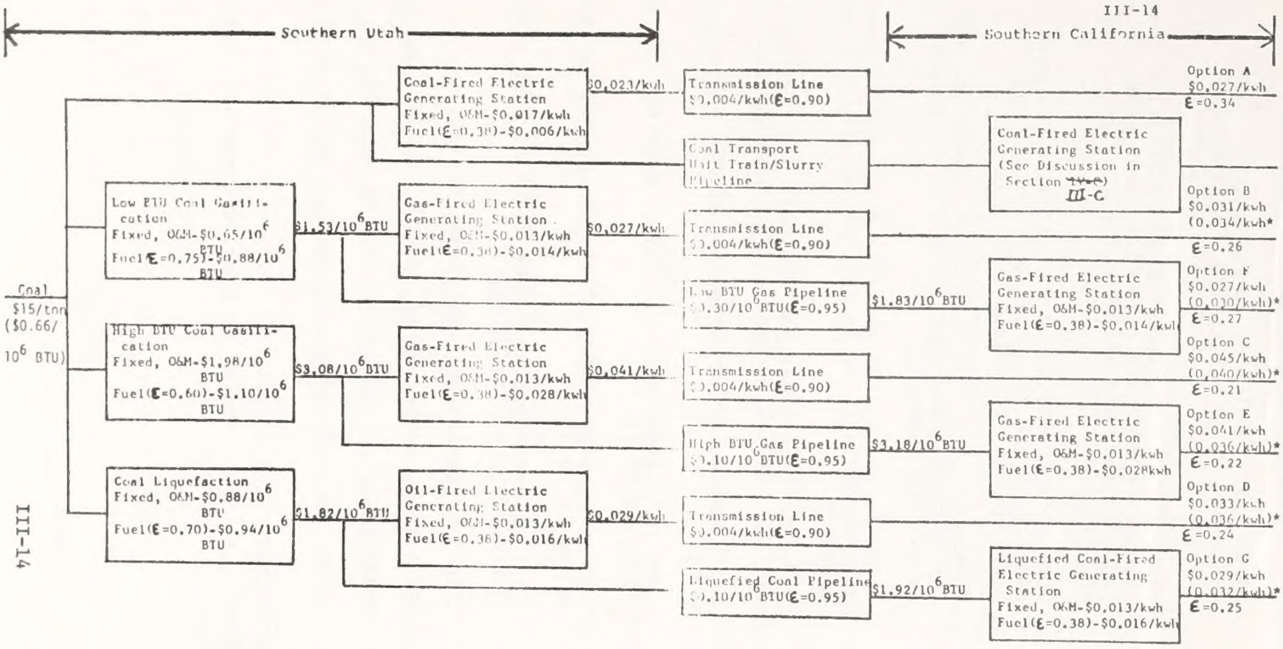
*See Project Independence, p. 286.

**From W. W. Bodle and K. C. Vyas, Oil and Gas Journal, August 26, 1974, p. 74.



*Cost figures in parentheses based on Southern California Edison estimates of gasification and liquefaction costs.

FIGURE IX

Table XI

Option	Cost* ($/kwh)	Efficiency**	Remarks
A	.027	.34	This is the utilities' preferred option; it provides the lowest cost power, it makes most efficient use of coal resources: and it involves the least technological uncertainty.
B	.031 (.034)***	.26	Options B through G have been rejected on grounds that (1) they involve unproved technologies (and hence there is potential for substantial cost growth) and (2) that the power thereby generated costs more at the point of entry to the distribution system than would be the case with power from the proposed project. In addition, the utilities would choose Options A through D in preference to Options E, F, and G, because the former uses Utah water. This relieves, to some extent, the utilities' problems in securing cooling water for generating stations located close to their market areas.
C	.045 (.040)***	.21	
D	.033 (.036)***	.24	
E	.041 (.036)***	.22	
F	.027 (.030)***	.27	
G	.029 (.032)***	.25	

*Cost of electric power (1974 dollars) at point of entry into Southern California distribution system. Costs at point of entry into a Arizona distribution system are approximately the same except that, in comparison with the California options, transportation of electric power is relatively less costly than in pipeline transportation of gas or liquid.

**Efficiency with which energy originally stored in coal is converted into electric energy as measured at point of entry into Southern California distribution system.

***Cost estimates in parentheses are based on Southern California Edison's forecast cost of coal gasification and liquefaction.

E. Nuclear Power Plants

All utilities participating in the Kaiparowits Project are also participants in various nuclear power plant projects:

Southern California Edison

San Onofre I;	344,000 kw (80% of 430,000); 1968
San Onofre II and III,	1,824,000 kw (80% of 2,280,000 kw) 1981
Palo Verde I;	195,000 kw (15.4% of 1,270,000 kw) 1982
Palo Verde II;	195,000 kw (15.4% of 1,270,000 kw) 1984
Palo Verde III;	195,000 kw (15.4% of 1,270,000 kw) 1986

San Diego Gas & Electric

San Onofre I; 86,000 kw (20% of 430,000 kw); 1968
" " II and III; 456,000 kw (20% of 2,280,000) approx. 1981

Arizona Public Service

Arizona Nuclear I; 357 Mw (28.1% of 1270 Mw); 1982
" " II; 357 Mw (28.1% of 1270 Mw); 1984
" : III; 357 Mw (28.1% of 1270 Mw); 1986

The costs (in 1974 dollars) of electric power in 1985 from Kaiparowits at point of entry to distribution systems in Southern California and Phoenix are estimated respectively to be $.027 and $.025 per kwhr. The 1985 costs in 1974 dollars of power from nuclear generating stations located in Southern California and near Phoenix at point of entrance to distribution systems are estimated respectively to be $.022 and .020 per kwhr.

There is general recognition that energy for all major new baseload electric generating facilities to serve the Kaiparowits market area will be either from coal related or nuclear processes. The decision to construct one type over the other will depend upon evaluation of various economic, technical and environmental factors; and the time at which the evaluation is made. In this case, the choice was dictated by the availability of coal, participating utilities' policy to reach what they consider a proper balance between nuclear and fossil fuels, and uncertainties with regard to the scheduling of nuclear generating stations.

Geothermal Generating Plants

The companies participating in the Kaiparowits project are investigating the potential of geothermal energy sources to serve needs in their respective market areas. The geothermal activities of these companies are as follows:

San Diego Gas & Electric Company's geothermal energy exploration and development began in January 1971. Wells were drilled in the Imperial Valley of California and flow tests were conducted to define the extent and potential of the geothermal resources. Subsequently, SDG&E engaged in testing equipment and overcoming scaling problems caused by the mineral-laden geothermal fluid. Since there is not yet any commercially proven equipment for converting the heat energy of the geothermal brines found in the Imperial Valley, they propose to construct a geothermal test facility in 1975. Assuming the most optimistic results with the test facility, the program could lead to an installed capacity of between 50 and 75 megawatts by 1981. This compares with SDG&E's 702 megawatt share of Kaiparowits generating capacity.

Southern California Edison entered into an agreement on September 6, 1972, with Southern Pacific Land Company and Phillips Petroleum Company to investigate the development of Imperial Valley geothermal brines to ascertain the feasibility of generating electricity. Initially, field efforts, commenced during the second quarter of 1973, were directed to establishing a reliable well production and injection system with emphasis on resolution and/or minimization of scale and corrosion problems. Power generation field testing will follow by the second quarter of 1975. The research work is expected to be completed by early 1976 resulting in recommendations for possible future pilot or demonstration "geothermal brine" generating units.

In early 1974, Edison signed a letter-of-intent with Magma Energy, Inc. for research and development of a binary cycle geothermal power plant in Mono County near Mannoth Lakes, California. The 10 Mw demonstration unit will be built on property owned by Magma and, subsequent to successful performance testing by January 1978, Edison will consider the purchase of the plant.

Arizona Public Service Company joined with the Salt River Project and Tucson Gas & Electric to partially fund exploratory drilling in Chandler, Arizona. The results to date have not been satisfactory and do not warrant expectations that geothermal energy would be a viable alternative to Kaiparowits. APS and SRP as members of the Electric Power Research Institute support work done by EPRI in the field of geothermal energy. None of the Kaiparowits participants believes that geothermal sources will, in the time frame of interest, provide more than a small fraction of the energy expected from Kaiparowits.

G. Investment in Energy Conservation Services*

An alternative to investment in the Kaiparowits electric generating station would be investment in systems which reduce energy consumption. For example, investment in more efficient lighting and cooling in commercial structures, or in residential thermal insulation would achieve essentially the same end as would investment in additional electric generating capacity for inefficient lighting, heating and cooling.

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*The conservation policies as stated by the Kaiparowits participants are listed in Appendix B.

Any discussion of alternative investment raises the question, "Alternative investment by whom?" Utilities have not traditionally made substantial investments in providing energy conservation services; legal barriers may in some cases prevent their doing so. But whether it be by utilities or by energy consumers, investment in conservation will lead to substantial monetary and energy savings.

One example of a system which provides economic and energy savings is that installed in commercial buildings for the purpose of monitoring and controlling the internal environment. Such a system includes elements which monitor temperature and humidity and which control blowers, chillers, pumps, and furnaces. Designed primarily to reduce peak power demand by 10% to 15% such a system also provides 15% to 25% savings in total energy consumption.

A typical 300,000 square foot commercial building in Southern California requires approximately 30 kwhr/yr/sq. ft. Peak power demand in such a structure is approximately 7.5 watts/sq. ft. If average savings could be achieved through use of an environmental control system, peak demand would be reduced by .75 watts/sq. ft. and total energy consumption by 1,800,000 kwhr.yr. Comparative costs and energy consumption with and without the above system:

Capital cost of environmental control system	$50,000
Capital cost of generating environmental and transmission capacity necessary in absence of environmental control system @ $500/kw.	$112,500
Cost of operating environmental control system; includes fixed costs of 20% and operating costs of 10% of investment.	$ 15,000/yr
Cost of 1,800,000 kwhr @ $0.032/kwhr.	$ 57,600/yr
Cost savings by virtue of installation of environmental control system.	$ 42,600/yr
Amount of energy resources not consumed as a result of 600,000 kwhr savings.	3000 bbls oil or 1050 tons coal/yr

In brief, investment in energy conservation systems brings about substantial energy resource and economic savings. However, the Kaiparowits utilities do not consider investment in conservation services to be a realistic alternative to investment in the proposed project. In the first place, these utilities imply that, legal barriers notwithstanding, they do not consider large scale investment in energy conservation programs within the scope of their activities. Moreover, as was noted previously (Section IIB), Kaiparowits is justified partly because it will displace existing oil fueled facilities. Thus, the utilities believe the Kaiparowits Project is needed in any event and it should proceed concurrently with programs which reduce electric power consumption.

H. Investment in Advanced Generation and Transmission Systems

A variety of advanced concepts in central station baseload generation and transmission are being developed. Some are closer to the point of economic feasibility than others. Some are of major significance and others represent modest improvements in efficiency.

The relative significance of a concept depends upon its potential for playing a role in satisfying electric energy demand. As with other alternatives, it is likely that if an advanced concept were to become economic, a higher priority would be given to decommissioning existing oil and gas facilities than to cancellation of Kaiparowits.

The following table lists the most promising central station and transmission techniques along with indications of significance and level of development. None of these have reached a point of development where they might affect the need for Kaiparowits' 3000 megawatts.

Concept	Potential Significance	Year of availability as an economically viable option
Fusion	Major	post 2000
Breeder Fission	Major	post 1990
Central Station		
Solar:		
Solar Thermal	Major	post 1990
Photovoltaic	Moderate Major	1985-1990
Bio-Conversion	Minor	Possibly never in the Southwest U.S. due to lack of water.
Wind	Moderate	post 1985
Magnetohydrodynamics	Moderate	1990
Large Fuel Cells	Moderate	1990-2000
Batteries	Moderate	1985
Nuclear Reactor Gas Turbine (possible elimination of most of water requirement in gas cooled reactors at some decrease in thermal efficiency)	Major	1990
High Voltage DC Transmission	Major*	1980
SF_6 Insulation Systems	Major*	1980
Superconducting of near-superconduction cables	Major*	1980
UHV Transmission	Major*	1980
Underwater Transmission	Major*	1980

* The significance of advances in the transmission technology lies in the fact that such advances mitigate siting problems by making possible greater separation between points of generation and consumption.

IV. Alternative Uses of Resources

Operation of the Kaiparowits Project would consume coal and water resources which might be used for purposes other than generation of electric power. Because coal reserves are abundant, the use of coal for purposes of electric power generation does not compete with the use of coal for other purposes such as gasification and liquefaction. Table XII indicates human, material, land, and energy resource requirements for Kaiparowits and its most viable alternatives.

The question of whether the use of Colorado River water for cooling Kaiparowits condensors represents the best use of this resource is a more complex question. The 45,000 acre feet required each year for condensor cooling is approximately:

0.7%--0.8% of total estimated available Upper Colorado Basin flow*

1.6%--2.0% of currently estimated unused Upper Colorado Basin flow*

3.0%--3.4% of Utah's total share of Upper Colorado Basin flow*

4.8%--5.8% of unused portion of Utah's share of Upper Colorado Basin flow*

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* From Figures 3 and 6, U.S. Department of the Interior Water for Energy Management Team, "Report on Water for Energy in the Upper Colorado Basin," (July 1974). The percentages listed above are based on the Department of Interior's "assumed" and "conservative" flows. These flows are 86.7% and 77.3% of the 7.5 million acre feet per year which were the basis for appropriations under the Upper Colorado Basin compact.

Table XIII indicates alternative uses of this water and the economic value of the product associated with such uses. Existing studies are inconclusive with regard to the likelihood of energy resource development in the Upper Colorado Basin being constrained by water availability prior to the year 2000.*

Moreover, whatever the merits of diverting Kaiparowits water to other purposes, there are practical obstacles to doing so. The participating utilities have contractual agreements with the State of Utah and the Department of the Interior which allow the use of this water solely for use in association with electric power generation at the Kaiparowits site.

Related to the water question is that the Upper Colorado River basin surface water supply is overappropriated in Utah;**i.e., water rights exceed supply. However the matter is resolved, the fact of overappropriation is unlikely to affect the Kaiparowits Project schedule.

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* Ibid.

**Federal Energy Administration, Project Independence Report, "Water Requirements, Availabilities, Constraints and Recommended Federal Actions." (U.S. Water Resources Council, Washington, D.C.) p.99.

TABLE XII

	Investment (Billions of Dollars)	Steel (Tons)	Concrete (Tons)	Land (Acres)	Engineering M/Yrs	Skilled Workers M/Yrs	Energy Resources Consumed/Yr
Kaiparowits Project As Proposed (Including Transmission Line)	$1.43	55,400	11,550	11,610	755	7,310	$9x10^6$ tons coal plus transmission line losses (See Assumption 4).
Coal Burning Generating Station in Southern California (Including Railroad Requirements)	$1.48	91,400	11,500	18,860	710	7,200	$9x10^6$ tons coal plus diesel oil for RR (See Assumption 4).
3000 Megawatts of Nuclear Generating Capacity in Kaiparowits Market Area (No Transmission)	$1.28	38,080	28,250	1,570	2,008	11,670	3000 Kgm U235

ASSUMPTIONS:

1. Transmission line assumed from Kaiparowits to Mohave for case of Project as proposed.
2. Length of railroad alignment assumed to be twice that of transmission line for case of rail transport of coal.
3. These estimates are approximate - based on minimum engineering - accuracy range is ± 25%.
4. Transmission line losses and energy consumed by rail transport are both 5% to 10% of energy generated.

Table XIII

Alternative Uses of 45,000 Acre Feet to be Used in Condensor Cooling at the Kaiparowits Project

	Approx. Impact on Oil Supply	Approx. value of annual Output ($ millions)
Kaiparowits (3000 megawatts, excludes water requirements for coal mine and associated community which might require an additional 7000 acre feet.)	Displaces 80,000 bpd	483 at generating station @$0.023/kwh
Oil Shale Production	200,000 to 600,000 bpd.	(1) 950-2850 @$13 per bbl
Coal Liquefaction	60,000 to 400,000 bpd; (40,000 to 300,000 bpd net). (2)	290-1900 @$13 per bbl
Coal Gasification	100,000 to 400,000 bpd. equivalent; (50,000 to 260,000 bpd.net). (3)	475-1900 @$13 per bbl
Coal Slurry	Sufficient for transport of approximately 200,000 tons of coal per day (equivalent of 700,000 barrels of oil per day)	
Irrigation of approximately 30,000 acres with typical Utah crop pattern (4)		

(1) No net energy figure is given since the oil shale process, which consumes approximately 0.4 barrels of shale oil for each barrel produced, consumes energy which otherwise would not be used; therefore, the concept of net efficiency of the process is not meaningful insofar as questions of alternative uses of resources are concerned.

(2) W. W. Bodle and K. C. Vyan, "Clean Fuels from Coal," The Oil and Gas Journal, August 26, 1974; p. 74

(3) High BTU gas; ibid.

(4) From information supplied to FEA by Upper Colorado River Office, Bureau of Reclamation in letter August 13, 1974.

V. Conclusions

The purpose of the foregoing discussion was to consider the need for the Kaiparowits Project, alternative means of satisfying that need, and alternative uses of the resources which will be consumed therein. The following conclusions relate only to energy aspects of the Kaiparowits Project. Any considerations of the Project as a whole should combine these conclusions with those resulting from an assessment of environmental impacts.

A. The FEA supports the Kaiparowits Project participants' position which holds that maintenance of adequate system reliability requires that Kaiparowits generating capacity be available as now scheduled. This support is based in part on the assumption that demand will grow approximately in accordance with the utilities' forecasts and that generating reserve requirements as specified by the utilities are necessary. While in actuality, demand may grow at a lesser rate, there is no solid basis for assuming such a lesser growth. The utilities' forecasts and reserve calculations are accepted because they are the most credible available.*

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*Recognizing that demand forecasts must necessarily reflect many subjective judgments, the FEA believes it important that there be forecasts compiled independently of those produced within the electric utility industry. Such forecasts would help to insure balance, they would lend greater credence to Government decisions permitting construction of generation and transmission facilities, and they would lead to more widespread participation in the economic planning process. The FEA is considering means by which independent forecasts might be encouraged.

B. FEA would support use of Kaiparowits coal for electric power generation even if growth in demand were less than now forecast as a result of increasing costs, government regulatory policies, and consumer conservation practices. This support would be based on the grounds that operation of a 3000 megawatt coal burning facility, in lieu of existing oil burning plants, would lead to the displacement of 80,000 barrels of oil per day. Early construction or conversion of a facility which uses coal from the Kaiparowits Plauteau would help achieve the President's proposed goal to eliminate by 1980 oil-fired plants from the Nation's baseload generating capacity.

C. At present, there are two technically viable and relatively economical power generation alternatives to Kaiparowits: (1) nuclear plants in the Kaiparowits market area, and (2) transportation of Kaiparowits coal to a powerplant site where air and water constraints are less severe than at the proposed site in Southern Utah. The nuclear alternative was rejected by the utilities on the grounds that in comparison with the relatively high likelihood of a coal-burning powerplant being brought into operation according to schedule, uncertainties in scheduling of nuclear plants made it unwise to place additional reliance upon nuclear power at this time. The utilities dismissed the alternative of transporting Kaiparowits coal to another site on the grounds that other potential sites were, with respect to a site on the Kaiparowits Plateau, less suitable in regard to one or more of the following:

water availability, ability to meet air quality standards, and economics of transport of Kaiparowits coal. (The environmental pros and cons of possible alternative sites are compared in the Environmental Impact Statement).

D. Other alternatives involve unproven and less energy efficient, but probably viable technologies. These are gasification or liquefaction of Kaiparowits coal and use of this coal for electric power generation either at the Kaiparowits Plateau or in Arizona and California market areas. A determination of the net desirability of such alternatives requires a comparison of their possible environmental advantages with disadvantages inherent in technological uncertainties.

E. Of some concern is whether the Kaiparowits Project leads to efficient use of limited resources. The fact that Kaiparowits displaces 80,000 barrels of oil per day is significant. Operation of Kaiparowits would reduce expenditures for foreign oil @$13 per barrel by approximately $380 million per year. Because coal is abundant, its use in this project does not compete with its use in other projects.

Water is another matter. Kaiparowits consumes approximately the same quantity of water as would be required in an oil shale production operation yielding 200,000 to 600,000 barrels per day or a coal gasification

plant yielding the equivalent of 50,000 to 260,000 barrels per day.

If the availability of water in the Southwest is the limiting factor in the production of energy resources, a net energy gain could be realized if Kaiparowits water from the Colorado River was shifted to use in oil shale production.* Such a shift would involve either constructing the Kaiparowits generating station at a site where water was more plentiful, or using a plant design with substantially less water demand at the Kaiparowits Plateau.

Water demand for the Kaiparowits Project could be reduced if the plant were built to use low Btu gas in a combined cycle generating system or with dry cooling system cooling towers. Neither of these technologies is considered to be economically feasible for this size installation in the time frame of interest.

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*As noted on Page III-7 there are legal obstacles to prevent using this water for other than electric power generation.

Appendix A

For purposes of decision making regarding additions to generating capacity, utilities compile forecasts of future demand. The primary assumptions made by each of the Kaiparowits participants in arriving at its current demand forecast were:

Arizona Public Service (1975-1980, 9.2% per year peak demand growth; 1980-1985, 6.6% per year peak demand growth):

- o Population growth will grow at a rate of 4% in years 1975-80, and 3.1% in years 1980-85.
- o GNP per person will continue to increase.
- o Decreasing availability of natural gas will lead to increased use of electric power for heating and cooling; namely, 55% of new home construction in 1974 and 75% in 1977.

San Diego Gas and Electric (1975-1980, 7.7% per year peak demand growth; 1980-1985, 5.2% per year peak demand growth):

- o Population will grow at a rate of 2.6% in years 1975-1980, and 2.4% in years 1980-1985.
- o Historical relationship between commercial growth and population will continue.
- o Historical relationship between population, household size and household use will continue.

Southern California Edison (1975-80, 4.7% per year peak demand growth; 1980-85, 4.9% peak demand growth)*

- o Population will grow at a rate of 1.2% in years 1975-1980, and 1.4% in years 1980-1985.
- o Increased prices, more energy efficient building design, and a conservation ethic will lower demand below that which has been forecast prior to the oil embargo; however, forces towards decreased use will be tempered by momentum inherent in existing behavior and connected loads.

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*Southern California Edison states that: "The major methods of attaining energy conservation have been incorporated into (its) forecast... These reductions are aimed at cutting energy waste and could be accomplished without causing severe economic dislocation. Any further reduction would lead to such economic dislocation as unemployment, reduced production, and the associated reduction in the personal income of the population served by SCE."

- o Government policies will continue to seek full employment for a growing labor force which will lead to increased energy consumption.
- o Uncertain natural gas supplies and the national effort to minimize dependence upon foreign energy resources will result in decreased use of oil and natural gas.
- o Residential development will concentrate in hotter regions of the service territory, which will add to increased power requirements for air conditioning.
- o Direct solar heating devices will not become economically competitive before 1985.
- o Real Gross State Product Growth rate will be 3.6% in 1975-80 period.*

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* Source Southern California Edison

Appendix B

Energy conservation policies as stated by the Kaiparowits participants are as follows:

Southern California Edison

A. PRINCIPLE

The Company, as an investor-owned utility, is in business to meet the demand of its customers for electric service. Efforts to encourage the efficient use of electricity, and the conservation thereof, are consistent with the goal of providing electrical energy and related services in a manner which is satisfactory to all customers.

B. ACTION RULES

1. Management and Conservation of Electric Energy

a. The Company shall undertake activities directed at reducing the rate of growth in demand for electric energy of residential, commercial, industrial, and agricultural customers by:

(1) Providing information to residential customers designed to assist them in their choices for efficient and economical use of electric power.

(2) Providing consulting services to commercial, industrial, and agricultural customers directed at advising them to reduce their overall energy requirements, and encouraging them to take action to minimize pollution.

(3) Encouraging trade associations and builder-developer groups to improve the efficiency of electrical equipment and institute building design, equipment selection, and construction practices which result in energy savings.

b. The Company shall plan for and operate its facilities in a manner which is consistent with increasing the efficiency of electric energy generation and the Company's use of electric energy.

c. The Company shall endeavor to develop and implement means of increasing the efficiency of electric energy uses and the elimination of wasteful practices.

2. Advertising/Communications

a. The Company shall not promote the increased use of energy through advertising, or incentive programs to builders and consumers.

b. The Company shall communicate to its customers and the general public what the Company is doing, is trying to do, and why, to the end that the best understanding and appreciation of the Company's activities will be achieved.

(1) Accomplishments of the Company, in, and positions on, electric energy conservation, environmental protection, and social action shall be fully communicated to employees and the general public.

(2) The Company shall conduct advertising aimed at providing environmental and conservation information, and encouraging shifts in consumer energy-use patterns to optimize utilization of all energy forms.

San Diego Gas and Electric Company

MARKETING DIVISION
ENERGY CONSERVATION PROGRAMS

The following is an outline of existing and planned programs and activities designed to conserve energy, and to advise customers on the wise use of energy.

The items are presented under headings that follow our Sales Department, Marketing Programs Department, Marketing Research Department and Advertising Department organization.

Sales Department

Major customers offer the greatest opportunity for our effort to promote wiser use of energy, peak-shaving, reduction in utility bills and more efficient utilization.

Sales Department sections are presently servicing 600 major industrial and commercial accounts. These accounts have been identified and assigned individually to Commercial/Industrial and Sales representatives. The "assigned account" program constitutes the majority of these representatives' time and responsibilities. Specifically they have been directed to establish liaison with top management and operating personnel of the assigned account firms.

In addition to assuring that these customers receive good service, our representatives have been instructed to counsel the customer on the elimination of wasteful energy practices and reassignment of energy utilizing equipment to prevent coincident usage with peak energy periods.

Following are plans in consideration or under way:

Industrial Customers

1. We are developing charts for the use of Sales Representatives to demonstrate the commercial and industrial customers the energy savings (as well as the dollar savings) in curtailing use of pilots connected with space heating, metal processing, solution tanks, etc., when the equipment is not in use, such as over week-ends.

2. Our Energy Utilization Engineer is studying development of a packet for Sales Representatives and Commercial/Industrial Representatives to use in demonstrating to industrial customers the energy saving (and dollar saving) possible by insulation of heated solution tanks. This material may be expanded into a seminar or course for Sales Representatives and plant engineers, plant managers, etc.

3. A similar study has resulted in plans to produce a Pipe Insulation Manual which will be loaned to plant engineers and major customers to encourage them to evaluate the present insulation of their steam and hot solution lines. Astounding results are seen from preliminary tests. The Manual is a very complex engineering text, but computerized pages reduce it to a simple application for industrial firms. We will encourage them to copy pages of the book that apply. The manual is produced by the National Insulation Manufacturers Association.

4. A program to enable our Sales Representatives to show industrial firms how to establish their own minimum ventilation requirements is in process. A manual produced by the American Conference of Governmental Industrial Hygienists has been acquired for the purpose. A kit will be supplied so that Sales Representatives can advise plant engineers how to remove contaminants at the source, rather than diluting air in the whole work area, thus wasting energy and dollars by over-ventilating.

5. We are developing monthly electric demand charts to be supplied to representatives calling on major accounts. These are actual print-outs of high demand of recent occurrences in a plant or customer premise, demonstrating graphically the effect on both customer billing (dollars) and SDG&E's system peak (energy). The Company representatives will use these to assist large customers to pin-point problems and solve them. They are designed to move load off our peak where possible (such as shutting off lights immediately after plant shut-down in a late afternoon, which in a test case kept 1600 kw of lighting off our afternoon peak... or moving certain heavy pieces of equipment off daily peak, such as a 1000 kw furnace recently rescheduled).

6. Electrical Maintenance Seminars are being conducted on a test basis with some of our major industrial customers. They are designed to illustrate how properly maintained heavy equipment will perform more efficiently and with less "down" time (dollars) and less production time (dollars as well as energy) when given correct and timely maintenance. In planning is a brochure for the purpose. A possible supplement is an Energy Conservation Award as an incentive in the program.

Government Sales

1. A plan is currently under way, in cooperation with Marketing Research Department, to conduct an exhaustive survey of U.S. Navy family housing in the San Diego area to determine possible methods of minimizing energy use. The program and materials will be produced by SDG&E, while the implementation will be entirely done by the Navy, who are most enthusiastic about the project. The survey will examine every area of energy use, including appliances, heating, cooling, hot water use, the effect of insulation, etc.

2. Preliminary meetings have been held looking toward a series of high-level conferences between SDG&E officials and command-level Navy people to examine every possible angle of efficient gas utilization, in view of possible curtailment in the coming winter months.

3. Energy consultations between Governmental Sales Representatives and local Navy commands are scheduled throughout the remainder of 1973, aimed at peak-shaving, moving loads off Company peaks, and more efficient use of energy by the Navy.

Home Economics

1. Continuing efforts are planned to add to the series of Appliance Utilization Booklets, which have been widely acclaimed throughout our industry as a pioneer project in providing the customer with advice and information on the wise use of energy. An added plan this year is to work with agencies for the disadvantaged and low-income groups, as well as to expand Spanish-language booklets, needed by Mexican-American communities in our serving territory.

2. A new plan in the Home Economics management contemplates better communication with women's groups, ethnic groups, low income and disadvantaged through a "newsletter" or "bulletin" to be issued monthly or perhaps quarterly. They have found a great need for direct communication -- there is no agency in San Diego supplying directly to the consumer information on nutritional meals, efficient cooking of foods, how to save money on food purchases, food preparation, energy use, etc. Timely is the U.S. Government's "Plentiful Foods Program," which would be included in the proposed communication. Women expect recipes, but the inclusion of energy-saving hints will be an important aim in such a publication.

3. Home Economics is scheduling production of a new series of "Cue" cards, which are interspersed with Recipe cards in the packets given to attendees at the hundreds of Women's Programs conducted by this department each year. The "Cue" cards contain hints on how to save money on utility bills (also saving energy), how to use appliances more efficiently, proper maintenance for energy conservation, etc.

Consumer Affairs

Our Consumer Affairs Counsellor has a comprehensive plan for production in 1973 of a consumer advice leaflet on "How to Cut Energy Use (And Save Dollars) Through Regular Maintenance of Household Equipment." Probes are going out now by mail to ask major appliance manufacturers for in-house and consumer literature on the subject. The need was discovered in reviewing the log of customer inquiries... many ask how to maintain equipment so as to operate it more efficiently and more economically

Marketing Programs Department

1. In conjunction with Advertising, Marketing Programs Department is developing a TV commercial on the efficient use of room air conditioners, offering an efficiency calculator and an air conditioning booklet describing how to keep the home at comfortable temperature through efficient air conditioner usage.

2. Further research is being conducted into the relative efficiencies of heating equipment, with special emphasis on the heat pump, and its benefits. For all-electric customers, these benefits include reduced energy use and reduced cost compared to standard electric heating-cooling systems. For customers in dual territory, the benefits are eventual heating-cooling economy when gas prices increase, and conservation of gas, a scarce commodity. Aimed at customers who have already decided to air condition, it will not influence demand for air conditioning, only the choice of systems. Also involves educational efforts with air conditioning contractors, builders and developers, advising them of heat pump efficiency.

3. A training program is in process to train sales representatives in use of a new computerized interior lighting design system which designs efficient lighting layouts for commercial/industrial customers. Current testing shows very encouraging results.

4. A major program in 1973 is our Insulation Program. In September, 1972 a Thermal Insulation Study was completed which indicated that up to 50% savings could be realized on heating and air conditioning cost in a fully insulated house. Furthermore, a survey indicated that 45% of the single family homes in San Diego County were uninsulated. As a result of the potential savings demonstrated in these studies, the insulation program was developed. It is directed toward two markets--new single family/multi family dwellings, and existing single family/multi family dwellings. SDG&E's objective in new home construction is to up-grade the building codes in San Diego County to require a minimum of 6 inches of insulation in the ceiling and 3 and 1/2 inches in the walls. At such time as this is accomplished, an effort will be launched to urge all existing home owners to install ceiling insulation wherever possible. It is contemplated that SDG&E will operate with the local insulation industry to insure that the above is achieved.

Marketing Research Department

By using existing charts from billing demand meters, Marketing Research is building load curves for commercial and industrial customers. The curves will measure the effect of load upon our peaks and show where shifting the demand will build a more favorable load factor. A growing number of demand meters have also been placed on residential units to accumulate representative load profiles of residential use.

Advertising Department

1. In planning for 1973, a series of 4-page inserts for local issues of national magazines and local magazines, on the "Energy Crisis" and what SDG&E is doing about it, is being developed.

2. Advertising themes for 1973 include this objective: "sell the virtue of energy saving--and offer ways to do it." To achieve this objective, TV commercials featuring animated "talking appliances" have been created to generate "top of the mind" awareness of how to save energy. Computer animation enables us to bring energy saving out of the ordinary into a new level of consciousness--at the same time offering booklets for customer-related information.

Outside Efforts

1. Efforts to encourage the development of automatic ignitors to replace gas pilot lights on ranges, furnaces and clothes dryers are being pursued among manufacturers. Mr. Zitlau recently wrote a letter to appliance and control manufacturers urging a crash program on this matter.

2. We are working with utilities and electrical leagues in the Western states to attempt to establish Energy Efficiency Ratios for different task, but we feel the consumer should know which brand will be least costly to him.

Arizona Public Service Company

It is the policy of Arizona Public Service Company to stress the wise and efficient use of electricity and natural gas supplied to customers. Further, it is APS policy to review continually all company operations to determine where improvements can be made to increase efficiency and conserve energy.

APS energy conservation efforts include but are not limited to:

- Research and development programs relative to new energy forms and sources.
- Power production efficiency measures.
- Reduction of power transmission and distribution losses.
- Consumer education programs promoting wise energy management and efficient energy usage.
- Adoption of internal operations policies designed to take advantage of the highest efficiencies possible in transportation, heating and cooling of buildings, and the use of all energy consuming machinery and equipment.

The scope and nature of the energy conservation programs of Arizona Public Service Company are on file with the Federal Power Commision pursuant to FPC Order No. 495, issued November 13, 1973, and reported in FPC Docket R-454.

Appendix C

MARGIN ANALYSIS OF GENERATING SYSTEMS

In order to provide reliable service to the public during times when forced outages are experienced at some generating stations, the installed generating capacity for U.S. utility companies is designed to be in excess of the anticipated peak loads. This incremental generating capacity over peak load is called margin. The margin requirements for utility systems arise due to unscheduled outages as particular plants which, for conventional power plants, are due to component failures. These unscheduled outages are separate from outages for scheduled maintenance and seasonal deratings of power plants.

There are various approaches to calculating the margin requirements. The simplest and one of the oldest approaches is to provide a generating capacity 15 to 20 percent in excess of peak demand. With the addition of very large power plants, some utilities adopted the loss of the two largest risks or, alternatively, loss of the largest risk plus 7 percent of peak demand. Because of the increased capital investment costs of power plants, a more precise determination of total generating requirements is desirable, which is based on probabilistic calculations, subject to a loss of load criterion. The most widely used method based on probabilistic techniques is called the "Loss of Load" method. This method measures the required reserve as a function of the probability of loss of capacity to meet demand. The term loss of load will usually be expressed in terms of days per year that some loss of load can be expected. The duration of the loss is unspecified. A common criterion for loss of load reliability of a system is one day in ten years. This means that on the average, over a ten year span, an electric generating system with this reliability would have an aggregate loss of load condition of only one day.

Because different systems have different characteristics, reliability calculations yield reserve margins which depend upon the particular characteristics of each system. For example, the utilities encompassed by the Mid-Continent Area Reliability Coordination Agreement required approximately 12% reserves to have a loss of load condition of one day per ten years while the New England systems required a 21% reserve to provide the same level of reliability.

APPENDIX I-2

An Independent Staff Analysis of the California Public Utilities Commission's Report on Ten-Year Forecasts of Electric Utilities' Loads and Resources

STATE OF CALIFORNIA—THE RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION

455 CAPITOL MALL, FIRST FLOOR
SACRAMENTO, CALIFORNIA 95814

August 29, 1975

Richard L. Maullin, Chairman
Energy Resources Conservation
and Development Commission

Dear Commissioner Maullin:

Enclosed is the Forecasting and Assessments Division's staff report on their technical evaluation of the California Public Utilities Commission ten-year forecast of electricity loads and resources. The report contains two sections, a brief summary and a technical analysis of the forecasts and methodologies used by the California Public Utilities Commission (CPUC) and the major utilities in the development of their forecasts. The major findings of the staff report may be summarized as follows:

1. The CPUC forecast is subjective and judgmental and not based on the use of accepted analytical techniques. Neither the assumptions nor the methodology are made explicit.

2. No alternatives were evaluated in the CPUC forecast, nor is there any way of determining the sensitivity of the forecasts to economic, environmental, demographic or institutional changes. Since the forecast is judgmental and inadequately documented, it is impossible to estimate its reliability. Mandatory conservation measures were not considered.

3. There is a wide variation in the forecasting techniques used by the major public utilities and the CPUC.

4. Most importantly, the CPUC report did not adequately analyze the implications of its forecast. An adequate conditional forecast would be structured so as to clearly indicate the costs and risks associated with any decision on capacity expansion, including the potential impact of delays in order to obtain better information on conservation potential.

This report represents only minor modifications to the earlier draft report; these minimal modifications were based almost entirely on the clarification of minor inconsistencies typical of those found in any preliminary draft. The main thrust of the conclusions remains unchanged.

One difference between the draft and final reports is that the presentation of the example forecasting methodology has been put in better perspective. The decision to restructure this example presentation was based on its almost universal misinterpretation. The example is presented merely as an illustration of a possible methodological improvement and not as a numerical forecast to be used for siting decisions.

We hope that this report proves a useful input in the continuing Commission deliberations.

PHILLIP S. MITCHELL, Ph.D.
Chief, Forecasting and
Assessments Division

PSM:dp

NOTE

The objective of this report is to outline the results of a staff evaluation of the electricity demand forecasts made by the California Public Utilities Commission and the major California utility companies for the period 1975 to 1984, as required under General Order Number 131 of the California Public Utilities Commission. This report was prepared by the Forecasting and Assessments Division of the California Energy Resources Conservation and Development Commission in fulfillment of the requirements of AB 1575, Section 25536.

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SUMMARY

The California Energy Resources Conservation and Development Commission (ERCDC) certifies sites and facilities for electrical generation within California. To support its certifications, the Energy Commission will develop forecasts of California electricity supply and demand for five-, ten-, and twenty-year periods. The resulting forecast will serve as an important input in determining the number and type of power plants which should be certified. The forecasting methodology will specify various sets of assumptions--sometimes called "scenarios"--regarding the future behavior of factors such as the price of electricity, the electricity rate schedule, the level of household income, the level of commercial and industrial output, the price and availability of such fuels as oil, natural gas and uranium, the degree of competition among the utilities, and the extent of conservation measures. The various conditional forecasts which result from these alternative "scenarios" may then be used as a basis for the biennial report, the first of which will be transmitted to the Governor and the Legislature on January 1, 1977.

Until the ERCDC forecasting methodology is complete, the Commission is required to evaluate and revise the ten-year forecast of loads and resources made by the California Public Utilities Commission. The results of the independent Energy Commission staff evaluation are summarized below.

Findings Regarding the California Public Utilities Commission Forecast

The Public Utilities Commission (CPUC), in their May 15, 1975 report, failed to provide sufficient information to permit systematic reconstruction of their forecast.

In addition to providing the details of its forecasting methodology, the CPUC should also have examined other forecasting methodologies and shown why its forecasting method is superior. The CPUC has provided virtually no analytical justification for its forecast or forecasting methodology.

The CPUC forecast is subjective and judgmental and not based on the use of accepted analytical techniques. It apparently represents the CPUC's first attempt to develop a forecast independent of the utility companies, and is not based on an explicit set of assumptions or reproducible methodology.

No alternatives are evaluated in the CPUC forecast, nor is there any way of determining the sensitivity of the forecast to economic, environmental, demographic or institutional changes. Since the forecast is judgmental, no statistical estimates of the confidence which may be placed in the forecast are possible.

Most importantly, the CPUC report does not adequately analyze the implications of its forecast. An adequate conditional forecast would be structured so as to clearly indicate the costs and risks associated with any decision on capacity expansion, including the potential impacts of a delay in order to obtain better information on conservation potential.

Finally, the California Public Utilities Commission forecast includes no net reduction in electricity demand from mandatory conservation measures. According to the Federal Energy Administration, federally-suggested conservation measures could reduce nationwide demand for electricity considerably by 1984. Neither Federal nor ERCDC programs were considered by the CPUC.

Findings Regarding Utility Company Submissions

The Energy Commission staff finds that the forecasting methods used by the utilities vary considerably in quality and that the data provided varies considerably in both quality and quantity.

In many respects, the formal forecasting methods used by Southern California Edison appear superior to those used by San Diego Gas and Electric, by Pacific Gas and Electric, and by Los Angeles Department of Water and Power. Nevertheless, the Southern California Edison model of demand for electricity is not adequately specified. A better-specified model could be constructed for each major customer class. Unfortunately, historical data associated with each rate class is lacking.

The formal model of San Diego Gas and Electric is also not adequately specified. That of Los Angeles Department of Water and Power is not disaggregated. Moreover, the LADWP presents little information upon which to construct a model. Pacific Gas and Electric presented neither formal nor informal models. It uses informal judgment in its forecast, but has not explained the nature of that judgment.

Not only did the utilities not use a uniform forecasting method, they did not use comparable data as inputs to their forecasts. The data used covers periods as different as that from 1956 through 1972 and that from 1965 through 1973. The length of the periods ranges from 11 to 17 years.

Conclusions and Recommendations

The staff finds the CPUC forecast and methodology to be inadequate for the Energy Commission's purposes. However, the staff is unable, at this time,

to present an adequate replacement forecast. In view of this finding and in accordance with the analysis presented to the Energy Commission by the Attorney General's Office, the staff recommends the following steps to assure timely future revisions and forecasts.

1. The ERCDC staff should prepare forecasts of future loads and resources for Commission consideration at such times as the availability of important new data, significant external events or institutional changes, or improvements in methodology warrant.

2. The staff notes that the timely production of these forecasts is partially dependent upon receipt of reasonably complete data from the electric utilities and other sources. Some of these data have been sought through formal requests and interrogatories, but have not been received in satisfactory form. The Commission should consider further measures to ensure receipt of these data as well as other more detailed data.

3. The staff will continue its own efforts to independently obtain the necessary data.

4. The staff will endeavor to produce its forecasts in sufficient time for meaningful Commission decisions.

CHAPTER I: THE ROLE OF FORECASTING

The objective of this introductory chapter is to discuss the uses of forecasting in general terms and to describe the Energy Commission's legal responsibilities vis-a-vis forecasting.

Forecasting

A forecast or prediction -- the terms are used almost synonymously by economists -- is a statement concerning unknown events, usually in the future.[1] The objective of forecasting is to systematically develop assessments of the future as inputs into a decision-making process. Thus forecasts are appropriate in all situations in which a current choice or decision has important implications for the future or vice versa. For example, in the case of a public utility company, a decision to commit large sums to electrical generating plant expansion would generally be based on a forecast of demand for electricity within the company's service area.

A forecast may be used:

- As an aid in systematic planning and resource allocation, especially in situations involving many complex, interrelated factors;
- As a means of reducing the costs or risks associated with uncertainty, by helping to narrow the range of uncertainty regarding future events or by testing the sensitivity of policy options to such uncertainty;
- As a means of assessing the economic, social, and environmental consequences of events and decisions.

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[1] "Forecast: to estimate or calculate in advance; predict or seek to predict." (Webster's New World Dictionary of the American Language - Second College Edition.)

In general, improvements in forecasts and forecasting should be judged in terms of the benefits accruing from improved decision-making relative to the costs associated with the forecasting operation. The primary consideration in committing resources to obtain a better quality forecast should, therefore, be based on the potential impact of the decision in economic, environmental and social terms.

To some degree forecasting will always involve elements of art and judgment. Formal forecasting techniques have the significant advantages of making assumptions explicit and having built-in tests of consistency. In addition, by relying on clearly specified data and techniques, formal forecasts, appropriately presented, facilitate independent, open review by interested parties. Even when highly sophisticated analytic techniques are used, there is a certain art to their selection and application. Conversely, when judgmental inputs are employed, it is still possible -- and perhaps even more important -- to be systematic and explicit about how such inputs are generated and used. These general considerations underlie much of the discussion of forecasting methodology in the rest of this report.

Variations in the development, use and interpretation of forecasts arise from institutional, as well as, methodological considerations. Individual utilities, government agencies, and institutions involved in forecasting have different and, from their point of view, equally valid perspectives and perceptions of economic, social and legal constraints. The Energy Resources Conservation and Development Commission and California Public Utilities Commission have broad social objectives that on occasion may differ from the corporate objectives of the utilities. Therefore, it is incumbent upon these governmental entities to structure the private decision-making environment through intelligent regulation in order to consider more fully and fairly these broader objectives.

Commission Forecasting Responsibilities

The primary regulatory activity of the Energy Commission is to consider the certification of power plant sites and facilities. Public Resources Code Section 25500 states that:

> In accordance with the provisions of this division, the commission shall have the exclusive power to certify all sites and related facilities in the state, except for any site and related facility proposed to be located in the [coastal zone] permit area, whether a new site and related facility or a change or addition to an existing facility. The issuance of a certificate by the commission shall be in lieu of any permit, certificate, or similar document required by any state, local or regional agency or federal agency to the extent permitted by federal law, for such use of the site and related facilities, and shall supersede any applicable statute, ordinance, or regulation of any state, local, or regional agency, or federal agency to the extent permitted by federal law.

The general requirement for forecasting in support of site certification, as well as other Commission activities, is contained in Public Resources Code Section 25216 which states in part:

> In addition to other duties specified in this division, the commission shall do all of the following:
>
> (a) Undertake a continuing assessment of trends in the consumption of electrical energy and other forms of energy and analyze the social, economic, and environmental consequences of these trends: ...
>
> (b) Collect from electric utilities, gas utilities, and fuel producers and wholesalers and other sources forecasts of future supplies and consumption of all forms of energy, including electricity, and of future energy or fuel production and transporting facilities to be constructed; independently analyze such forecasts in relation to statewide estimates of population, economic, and other growth factors and in terms of the availability of energy resources, costs to consumers, and other factors; and formally specify statewide and service area electrical energy demands to be utilized as a basis for planning and siting and design of electric power generating and related facilities. ...

To fulfill its responsibilities the Energy Commission conducts three separate but related forecasting activities. First, the Energy Commission reviews

and may make revisions to the 10-year forecast of electrical loads and resources found in the CPUC's G. O. 131 report, in accordance with the process set forth in Section 25536 of the PRC excerpted below:

> Pending completion of the statewide and service area forecasts of electric power demand specified in Section 25309, the commission shall utilize as an interim forecast for purposes of determining the acceptability of alternative site and related facility proposals as provided in subdivision (a) of Section 25514 and subdivision (d) of Section 25523, the 10-year forecast of loads and resources prepared by the Public Utilities Commission from reports required or submitted as of March 31, 1974, under Sections 2 and 3 of General Order 131 of the Public Utilities Commission. ... [Hearings] shall be conducted to secure the views and comments of the public, the electric utilities, other state and federal agencies, the city and county governments regarding revision of the interim forecasts based on the considerations specified in Section 25304 and on updated information regarding forecast loads and resources submitted by any electric utility. Such hearings shall be concluded within 30 days from the date of their commencement. Within 60 days of the conclusion of the hearings specified in this section, the commission shall issue a final report specifying the revisions, if any, to the interim forecast. The report shall be based upon the information and views presented at the public hearings and the commission's independent analysis. (Emphasis added.)

This forecast, as revised, is thus the Energy Commission's forecast until the Commission's second forecasting task is completed or until such time as other revisions may be approved.

The second and broader forecasting requirement is set forth in Sections 25300, 25301 and 25304 of the Public Resources Code. Section 25300 requires that every electric utility in the state prepare and transmit to the Commission by January 7, 1976, a report specifying 5-, 10-, and 20-year forecasts or assessments of loads and resources for its service area. This report also identifies the facilities which, as determined by the electric utility, will be required to supply electric power during the forecast or assessment periods. The report requires each utility's report to include:

(a) A tabulation of estimated peak loads, resources, and reserve margins for each year during the 5- and 10-year forecast or assessment periods, and an estimate of peak load, resources, and reserve margins for the last year in the 20-year forecast or assessment period.

(b) A list of existing electric generating plants in service, with a description of planned and potential generating capacity at existing sites.

(c) A list of facilities which will be needed to serve additional electrical requirements identified in the forecasts or assessments, the general location of such facilities, and the anticipated types of fuel to be utilized in the proposed facilities.

(d) A description of additional system capacity which might be achieved through, among other things, improvements in (1) generating or transmission efficiency, (2) importation of power, (3) interstate or interregional pooling, and (4) other improvements in efficiencies of operation.

(e) An estimation of the availability and cost of fuel resources for the 5-, 10-, and 20-year forecast or assessment periods with a statement by the electric utility describing firm commitments for supplies of fuel required during the forecast or assessment periods.

(f) An annual load duration curve and a forecast of anticipated peak loads for each forecast or assessment period for the residential, commercial, industrial, and such other major demand sectors in the service area of the electric utility as the commission shall determine.

(g) A description of projected population growth, urban development, industrial expansion, and other growth factors influencing increased demand for electric energy and the bases for such projections.

25301. The commission shall establish and every electric utility shall utilize, for the purposes of the report, a common methodology for preparing forecasts of future loads and resources. ...

25304. The commission shall review and evaluate the electric utilities' forecasts of loads and resources, and the comments of the Public Utilities Commission on such forecasts, in relation to the population growth estimates prepared by the Department of Finance, Population Research Unit, and in relation to statewide and regional land use, transportation, and economic development programs and forecasts. ...

Finally, the Commission will produce a biennial report as specified in Public Resources Code Section 25309. This report includes broader forecasts of trends and factors affecting energy supply and demand.

In consideration of these mandates, the staff has prepared this Report. Chapter 2 is a critical review of the CPUC and the electric utilities forecasts of loads for the next ten years. It is followed by a description of proposed steps for ensuring that future powerplant siting decisions will be based on the most current and comprehensive forecasts and forecasting methods available.

CHAPTER II: ANALYSIS OF CALIFORNIA PUBLIC UTILITIES COMMISSION AND ELECTRIC UTILITIES FORECASTING METHODOLOGIES

INTRODUCTION

The purpose of this chapter is to appraise the forecasts and forecasting methodologies developed by the California Public Utilities Commission and the electric utilities pursuant to General Order 131 (G.O.131).

The appraisal will show that the forecasting methods are inadequate for the purposes of making clear and widely understood estimates of the future demand for electricity. Specific deficiencies in the forecasts and methodologies will be detailed in this chapter. Chapter III will outline various revisions needed to provide a more satisfactory method for estimating future demand for site approval and other purposes.

Forecasting is usually made with a number of critical uncertainties and is therefore subject to errors. This is particularly true of forecasting electricity consumption in view of incomplete information about the responsiveness of demand and supply to changes in the price of electricity and alternative fuels, the effects of mandatory conservation measures, and the economic conditions of the region and the utility industry. It is inevitable that the preparation of a forecast requires choices from among many alternative assumptions regarding the future of the world in which we live. It is, therefore, vital that the reasoning and judgment which underlie the choices made in any forecasting methodology be clearly and explicitly stated. This requires that the relationships among the variables considered in the forecast be expressed in the form of mathematical equations, that the semantic rules relating each variable to observable data be carefully stated, that the statistical procedures for estimating each parameter expressing the relationship between the variables

be specified, and that the procedures for estimating -- either statistically or on the basis of informed, reasoned judgment -- the future values of the independent variables and parameters be clearly stated.

Unfortunately, the California electric utilities currently use neither a common systematic forecasting method nor the same types of data inputs, so it is difficult to compare their methods. This chapter compiles, discusses, and summarizes the important specifications and assumptions of their methodologies and presents a review of their common methodological elements.

COMMON ELEMENTS

Table 1 presents a summary comparison of the electric utilities' methodologies, specifications, explanatory variables, and data sources. As the table clearly indicates, there are as many different approaches to energy demand forecasts as there are electric utilities. This wide variance in methods is a principal difficulty in evaluating the interim forecasts. Another major stumbling block to evaluation is the fact that not only are data sources different for each utility, they appear to be inadequate for acceptable forecasting. Since data are the key inputs for estimating forecasting equations, it is important to discuss the data used by the electric utilities.

Data

The structure of the data used in the forecasting methodologies tends to invalidate their use as the basis for statewide long-range planning.

The historical data covers different years for different utilities. The data used begins as far back as 1956 in one case and as recent as 1965 in another.

TABLE 1
SUMMARY OF UTILITY SUBMISSIONS FOR G.O. 131

	Pacific Gas & Electric (PG&E)	Los Angeles Department of Water & Power (LADWP)	Southern California Edison (SCE)	San Diego Gas & Electric (SDG&E)
Demographic Variables				
Birth rate	historical data not reported projections not reported	apparently not used	historical data reported; source not specified projection of 1.8 - 2.1 per woman basis for projection not reported	apparently not used
migration rate	historical data not reported projections not reported	apparently not used	historical data reported; source not specified projection of 100,000 /yr. for State based upon Department of Finance projections	apparently not used
population	historical data reported Source: Department of Finance Report 74P-1 projections based on Department of Finance D-100 series	historical data reported projections based upon City of L.A. Planning Dept.	historical data reported; source not specified projection of 1.2 - 1.3% annual based upon Cohort-component model	data reported; source not specified projections based upon Department of Finance D-100 Series
population-customer ratio	historical data reported: source not specified projection of 1.0% annual decline basis for projection not reported	apparently not used	historical data reported; source not specified projection of 3.01 - 2.78 per customer basis for projection not reported	number of customers forecast from population projections

The last years included in the respective utility forecasts range from 1972 to 1974. Also, the range of years chosen varies from 11 to 17 years. It will be shown in the analysis of the Southern California Edison methodology that the selection of data is an important factor influencing forecasts.

A very important point is that the forecast methodologies should include the most recent data available, even though recent events -- such as the oil embargo -- have caused some analysts (SCE, for example) to conclude that these data are anomalous and should be excluded. Actually, the 1973 and 1974 data are not anomalous. The tendency to conclude they are results from examining the relation of individual variables with time instead of examining the relation of individual variables with each other. In 1974, for example, electricity sales fell; however, so did output and income levels, which are two important factors affecting electricity use.

SUMMARY OF UTILITY SUBMISSIONS FOR G.O. 131

	PG&E	LADWP	SCE	SDG&E
Income & Business Activities Variables Gross Nat'l. Prod.	historical data not reported projections not reported	apparently not used	historical data reported in written submissions forecasts from projections of productivity, etc., furnished in written submissions	historical data reported; source not specified projection of 4.1% annual growth from UCLA study
Gross State Product	historical data not reported projections not reported	apparently not used	historical data reported; source not specified 2.9% annual growth rate based on assumptions re productivity changes, etc.	apparently not used
Real Disposable Personal Income	historical data not reported projections not reported	historical data reported in written submissions projections not reported	historical data reported; source not specified projection of 2.9% annual growth by assuming RDPI x GSP	historical data report source not specified projections based on UCLA study
Employment	historical data not reported projections not reported	historical data reported in written submissions projections not reported	historical data reported; source not specified projection of 1.7% annual growth rate basis not reported	apparently not used
Business Indices	historical data not reported projections not reported	historical data reported in written submissions projections not reported	apparently not used	apparently not used

TABLE I (cont.)

SUMMARY OF UTILITY SUBMISSIONS FOR G.O. 131

	PG&E	LADWP	SCE	SDG&E
Price Variables average price of electricity	historical data reported in interrogatory response projections not reported	historical data reported in written submissions 0-4% annual growth projected	historical data reported in response to interrogatories projections not reported	historical data reported in response to interrogatories projections not reported
marginal price of electricity	historical data not reported projections not reported	historical data not reported figures not projected	historical data not reported projections not reported	historical data not reported projections not reported
price of natural gas	historical data not reported projections not reported	historical data not reported figures not projected	historical data not reported projections not reported	historical data not reported projections not reported
End Use Variables appliance saturation	historical data not reported projections reported; basis not specified	reported in answers to interrogatories	historical data reported; source: Biennial Saturation Survey projections reported based on multiple regression analysis	apparently not used

TABLE I (cont.)
SUMMARY OF UTILITY SUBMISSIONS FOR G.O. 131

	PG&E	LADWP	SCE	SDG&E
Model Specification & Method of Estimation Residential Customer Sales	Model specification not reported Method of estimation: regression Uses "no formal or informal statistical model"	Model not separated by customer class: $Total\ Sales_\tau =$ $b_0 +$ $b_1\ POP_\tau +$ $b_2\ BUS.\ INDEX +$ $b_3\ PRICE$	Model specification:* 1. $RCUS_\tau = POP_\tau / PCR_\tau$ 2. $ARU_\tau - ARU_{\tau-1} = a + b\ (RDPI_{\tau-1} - RDPI_{\tau-2})\ c\ (TE_\tau - TE_{\tau-1})$ 3. $TRU_\tau = RCUS_\tau \times ARU_\tau$ Method of estimation: regression	Model specification:* 1. $RCUS_\tau = a + b\ POP_\tau + c\ RDPI_\tau + d\ LGPOP_\tau + e\ LGPI_\tau$ 2. $ARU = a + b\ LGPOP_\tau + c\ RDPI_\tau + d\ LGPOP_\tau + e\ LDPI_\tau$ 3. $TRU_\tau = RCUS_\tau \times ARU_\tau$ Method of estimation: regression
Commercial	Model specification not reported Method of estimation: regression Uses no formal or informal statistical model	See residential customer sales	Model specification:* 1. $CCUS_\tau = f(RCUS_\tau)$ 2. $ACU_\tau - ACU_{\tau-1} = a + b\ (GSP_{\tau-1} - GSP_{\tau-2}) + c\ (RDPI_{\tau-1} - RDPI_{\tau-2}) + d\ (TE_\tau + TE_{\tau-1})$ 3. $TCU_\tau = CCUS_\tau \times ACU_\tau$ Method of estimation: factor analysis	Model specification:* $TCU = f(POP_\tau)\ RDPI_\tau)\ GNP_\tau)$ Method of estimation: principle components
Industrial	Model specification not reported Method of estimation: regression **Uses no formal or informal statistical model**	See residential customer sales	Model specification:* $TIS_\tau - TIS_{\tau-1} = a + b\ (GSP_\tau - GSP_{\tau-1})$	Included in commercial model

*** Symbol definitions are listed at end of summary table.**

TABLE I (cont.)
SUMMARY OF UTILITY SUBMISSIONS FOR G.O. 131

	PG&E	LADWP	SCE	SDG&E
Other Public Authority	Model specification not reported	See residential customer sales	$OPA_\tau = a + b\ TRU_\tau$ Method of estimation: regression	assumed constant
Resale	Model specification not reported	See residential customer sales	$Resale_\tau = a + b\ (TRU_\tau + TCU_\tau + TIU_\tau)$ Method of estimation: regression	NA
Data	Time series 1961-74	Time series 1959-74	Cross section Time series 1964-74	Time series 1956-72
Conservation Program Effects	No explicit conservation measures listed; overall effects assumed captured by price adjustments.	No explicit conservation effects listed.	No explicit conservation measures listed; overall effects assumed captured in a conservation and price model.	No explicit conservation measures listed; overall effects assumed captured by price adjustments.

Table 1-Continued

SUMMARY OF UTILITY SUBMISSION FOR G. O. 131

RCUS = number of residential customers

POP = population/LGPOP=log of population

PCR = population - customer ratio

ARU = average annual usage per residential customer

RDPI = real disposable personal income

LGPI = log of real disposable personal income

TE = total employment

TRU = total residential usage

CCUS = number of commercial customers

ACU = average annual usage per commercial customer

TCU = total commercial usage

GNP = gross national product

GSP = gross state product

TIU = total industrial usage

OPA = other public authority sales

RESALE = resales to other utility companies

It is not only from a consideration of the disparate data bases that the forecasting methodologies are found wanting for the purpose of constructing a statewide model. Several other important considerations concerning the use of extrapolation techniques, the treatment of the price of electricity and competing energy forms and their associated price elasticity, the overall model specifications, the method of projection, and statistical rigor are all cause for concern.

Extrapolation Techniques

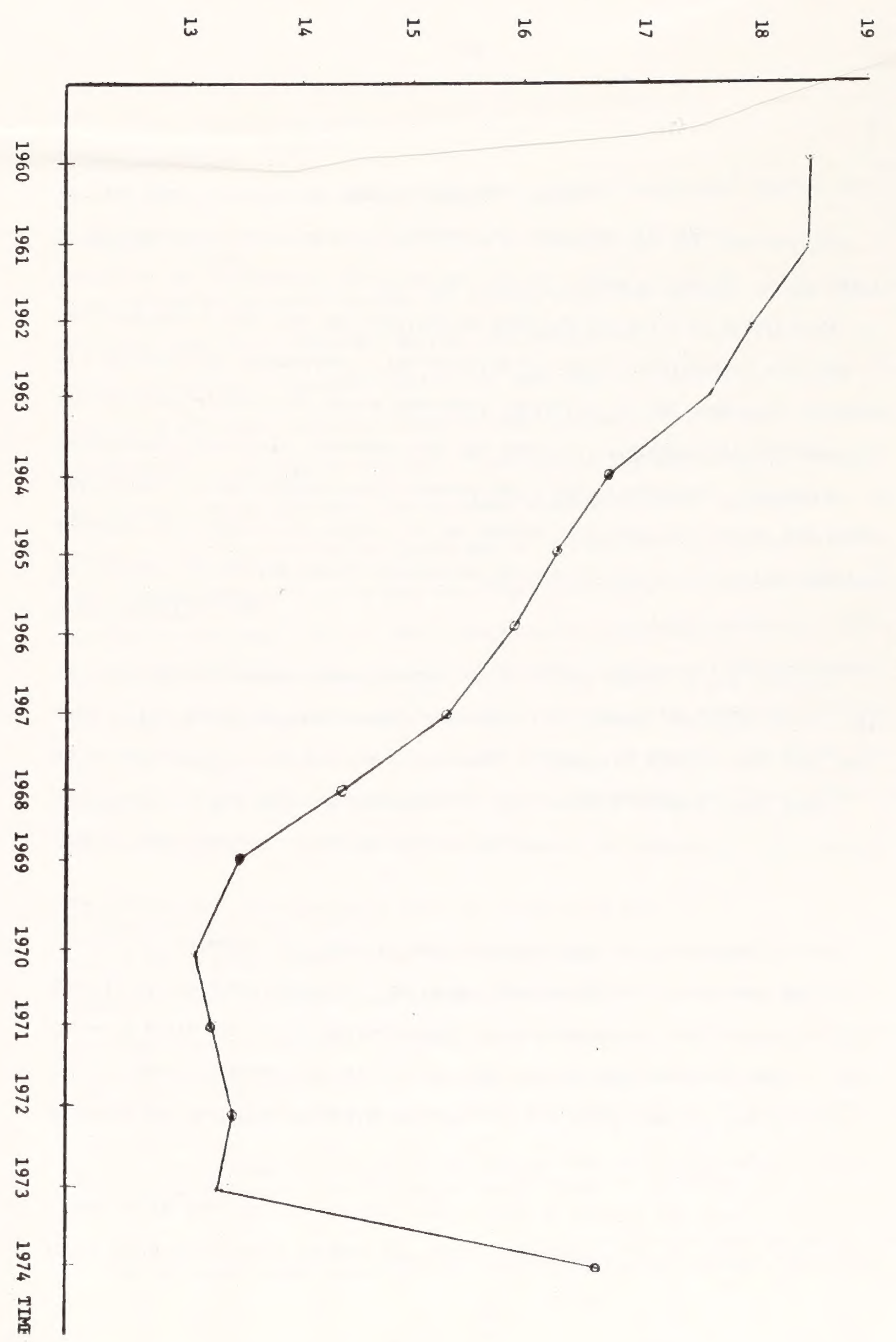
Some electric utilities (such as the Los Angeles Department of Water and Power) have based their forecasting methodology exclusively upon the use of either extrapolation of trends in factors which they think determine energy demand or extrapolation combined with regression analysis.

The major shortcoming of applying the extrapolation forecasting technique is that the factors which determine demand are presumed to affect future demand precisely as they did in the past. In the past, forecasts using extrapolation of historical trend may have been reliable indicators of the direction of change in electricity demand, but in view of the significant changes that have been occurring over the past several years the extrapolation technique is no longer a valid foundation.

Extrapolation is inappropriate for both short-range and long-range forecasts because it fails to account for recent changes in important variables. For example, capacity additions to electricity generation have in the past given rise to economies of scale which in turn resulted in lower real electricity prices. Figure 1 shows the recent trends in electricity prices in California. Because the real price of electricity in the 1960's was

ELECTRICITY PRICE HISTORY FOR CALIFORNIA

FIGURE 1



1 **Weighted average price from Table 2.**

decreasing relative to other consumption goods, the amount of electricity demanded increased. However, the costs of electricity since 1973 have been rising steeply and no quick reversal seems likely. The strongest assumption of the extrapolation technique -- that there are no deviations from historical patterns -- does not allow full measure of recent price effects or, just as importantly, ignores changes in consumer attitudes toward energy use, conservation actions already taken and likely to be taken, the regulatory climate, supply patterns and so forth. For these reasons the extrapolation technique should be rejected as a technique for forecasting electricity supply and demand.

Price of Electricity

Each submission is based upon a methodology which does not explicitly incorporate price as an explanatory variable for the amount of electricity consumed bv customer class. At the very least, the price of electricity should be included as an independent variable in a single equation model. Of course, there remains considerable controversy over how price is to be measured in view of the declining block rate schedule for electric utilities; simply using average historical prices is not the appropriate way to introduce price. If average and marginal price are positively correlated, as they are likely to be, then there will be an upward bias in the estimate of the price elasticity (that is, the estimate of the price elasticity will, on the average, be greater than the actual price elasticity). To avoid this bias both the average price per kilowatt hour of the electricity consumed, up to but not including the final block, should be entered along with the marginal price of the last block consumed. Along with the problem of including price as an explanatory variable in demand forecasts goes the problem of how price elasticities should be entered.

Elasticity of Demand

Only Southern California Edison and San Diego Gas and Electric attempt to incorporate explicitly the price elasticity of demand for electricity into their methodologies. If the basis for the exclusion by the others is the argument that the demand elasticity is insignificantly low or even zero, and for this reason should not be included in a forecast of demand growth, then the argument can be refuted by empirical evidence as well as on theoretical grounds. If it is argued that none of the many available studies on demand elasticity is applicable to the service area under consideration, the utility should conduct its own study of elasticity estimates in its particular region in order to improve its forecasting methodology, as Southern California Edison has recently done. At the very least, a range of existing elasticity estimates could be included parametrically for each service region.

The effects of the price of electricity on consumption will vary depending upon the length of time considered; the effects must be viewed as a combination of short-run and long-run adjustment problems. The impact on the demand for electricity of a change in the price of electricity will operate in the short-run through variations in the frequency and extent of use of the fixed stock of electricity-using goods. In the long-run it will also operate through changes in the stock of electricity-using goods. Thus, when the price of electricity takes a dramatic upturn, such as in the recent past, it can be expected that people will have very little incentive to replace the energy-using goods which they possess simply because operating costs will have risen. They will have the incentive to reduce their use of these goods. As these goods age and need to be replaced, however, it can be expected that people will search for a replacement which is more efficient in its use of electricity, substitute a good which does not use electricity, or even do without the good."

Accurate and reliable estimation of both the short-and long-run elasticities require detailed household data on the stock of electricity-using goods. While long-run price elasticity estimates may be constructed without such data, the quality of these estimates will be rather questionable. Even though existing elasticity estimates have several deficiencies, they nevertheless give us some insight into the effects of price on electricity use.

Thus,in constructing a model of electricity demand one necessarily must include both short-run and long-run adjustments. This means a dynamic model must be constructed since only a few of the many econometric studies that have been made of the demand for electricity are explicitly dynamic and allow for a logical distinction between demand in the short-run and demand in the long-run.

Model Specifications

All of the forecasting models constructed by the utilities use only a single equation for electricity demand, yet an appropriate specification of any econometric model would involve both a demand and a supply equation. In such a simultaneous equations framework both the quantity of electricity demanded and the price of electricity become dependent variables and the remaining variables are exogenous or independent. The solution of such a simultaneous equation system involves determining the equilibrium quantity and price of electricity. Shifts in the independent variables may then be linked to changes in the equilibrium values of the price and quantity of electricity via the "reduced form" derived from the estimated general model.

No definitive studies have been published on how to include supply effects into forecasting models, but special studies are currently underway. Introducing a supply side into the model allows for the consideration of some of the most important questions in any model of the electricity sector. In particular, policies designed to reduce excess capacity can be examined. These would include peak load pricing and other alternative pricing strategies designed to increase the price to any customer for using electricity at a peak time of day or season of the year. This would result in a smoothing of the load normally experienced by a utility and would consequently reduce the amount of capacity that, under current pricing strategies, is used only to supply peak demand. Such a reduct. in required capacity would reduce the resource costs for producing electricity and the price of electricity to ultimate consumers, as well as conserve our natural resources and preserve our environment.

Scenario Development

Instead of a series of estimates based upon slightly different assumptions regarding the projected values of the independent variables, each of the utilities presents only one forecast of electricity demand. In view of the uncertainty surrounding any forecast of electricity demand, it would seem inadvisable to make a forecast based upon only one projected set of values for all the independent variables.

Statistical Rigor

Each of the submissions is deficient in that whenever statistical results are presented, some of the relevant statistical tests are left out.

Since regression analysis involves the estimation of coefficients in the specified equations, it is important to know whether the estimated coefficients are indeed significant. The usual statistical test for each coefficient is the t-test and is usually reported along with each estimated coefficient. In general, the higher the t-statistic, the more significant is the estimated coefficient. For instance, in an equation relating total electricity sales to population and income, a high t-statistic for income and low t-statistic for population would indicate that population size does not affect total sales in a significant way, but that income does. In addition to testing each estimated coefficient individually, it is also important to know whether the specified set of independent variables is significant in explaining the variation in the dependent variable. The usual statistical test for this is the F-test. In general, the higher the F-statistic the more significant is the set of independent variables in explaining the variation in the dependent variable.

Statistical Testing Procedures

One of the crucial assumptions of the ordinary least squares model[2] is serial independence of the disturbance (or error) term.[3] This assumption implies that the error term in one period is independent of the error term in another period; i.e., the next period's error term cannot be prediced from knowledge of this or any other period's error term. However, there are circumstances in which there are serially correlated disturbances. Such serial correlation occurs most frequently in estimation involving data collected over time and such circumstances generally result from having omitted important variables. For instance, if prices are important in the determination of electricity consumption and a model fails to include this important variable, the effects of price are hidden in the error term.

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[2] An ordinary least squares model is used to find the linear relation which is considered the best fit for the values of a set of variables.

[3] The error term in an equation is the term which indicates the amount by which the estimated values exceed or fall short of the actual values.

In addition, the existence of measurement error in the dependent variable (such as residential electricity consumption) may also be a source of serial correlation. In the event that the ordinary least squares regression technique is applied when serial dependence exists, the consequences are as follows: first, unbiased estimates of the regression coefficients are obtained but the significance of these estimates is seriously overstated; second, the ordinary least squares formulas for the t and F statistics are no longer valid; third, predictions with needlessly large confidence intervals will be obtained. It is important to be able to test for the presence of autocorrelated disturbances and if necessary to adopt alternative estimating procedures. The Durbin-Watson statistic may be used to conduct this test.[4]

If it appears from the results of the Durbin-Watson test that autocorrelated disturbances are present, one acceptable procedure to follow is the Cochrane-Orcutt[5] interative process. This process involves first performing least squares regression analysis, making some assumption about the nature of the autoregressive scheme (for example, that it is a first-order autoregressive scheme), and estimating rho, the autocorrelation coefficient. This estimate of rho is then used to

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4/ For a complete discussion of the Durbin-Watson statistic, see (14) p.249.

5/ (15) p.263

transform the original variables after which ordinary least squares is again applied to estimate the relation between these transformed variables. If the residuals from this second relation are not significantly autocorrelated, the estimation procedure ends. If they are significantly autocorrelated, these new residuals are used to provide yet a third estimate of rho and this new estimated rho in turn is used to compute a new set of transformed variables. This procedure is continued until a random set of residuals results.

In the absence of any information about rho, some econometricians assume it to be unity, in which case the appropriate transformation is to take first differences[6] of the variables. In view of the availability of the Cochrane-Orcutt method for estimating rho and adjusting for autocorrelation, however, this course of action is not satisfactory.

A final important point to consider is whether or not the forecasting methodology includes all independent variables simultaneously in the forecasting estimation. The current methodologies of the utilities do not permit such a simultaneous determination. If all the economic and demographic factors are properly included, the total effect of all the variables on each other and the amount of electricity demanded may be determined simultaneously and thus may avoid spurious statistical correlations.

6/ The first difference equations focus on the year-to-year changes (that is, the difference between actual values in one year and the values in the preceeding year) rather than on the levels found for each year. (16) p. 187.

SOUTHERN CALIFORNIA EDISON

Introduction

The Southern California Edison (SCE) methodology is the best among all the utilities.[7/] Forecasts of annual loads are made for the following customer classifications: residential, commercial, industrial, public authority, resale, and agriculture. The forecasting procedure consists of a base estimate of loads which is "modified" to account for the effects of price rises and of conservation programs. The latter is estimated only indirectly by assuming that the price effect includes the effect of explicit conservation actions.

The base forecast includes the following as the major explanatory variables:

1. Weather;
2. Total state employment;
3. State real disposable personal income;
4. State real gross state product; and
5. Population.

SCE estimates of price elasticities for each customer class are applied to these projections to arrive at the final forecasts. These elasticity estimates are discussed in detail under "Price Elasticity".

Residential Demand Model

The forecasts of residential customer loads were derived from estimates of household growth and average electricity usage per customer. The household growth projections are based upon a cohort-component model similar to that used by the California Department of Finance. Population per customer is forecast to decline over the forecast period due to lower birth rates and a continued trend toward smaller households. The usage per customer in period t, U_t, is related to real California disposable personal income lagged one year, $RDPI_{t-1}$ and current total employment, TE_t. The parameters of the model are estimated from first differences, presumably to compensate for autocorrelation in the time series data from which the parameters are estimated. The yearly change in electricity demand (ΔU) for the year t is given by the formula

$$\Delta U_t = 57.52 + 34.35\ (\Delta RDPI_{t-1}) + 0.70\ (\Delta TE_t).$$

While the dependent variable, U_t, is measured on a per customer basis, the disposable income variable, RDPI, is not. A better specification for the income variable would be in terms of per customer personal disposable income in the service area. Alternatively, the specification could be in terms of total residential sales in the service area and total personal disposable income. The specification adopted by SCE is a peculiar amalgam of these two approaches and does not follow from conventional demand analysis.

It should also be noted that the dependent variable, use per residential customer, has been adjusted to account for the effects caused by changes in the weather. It is not readily apparent how weather-normalized sales data were derived from the recorded sales data. Consequently, recorded data have been used to develop Commission analyses described below; it will be apparent from the discussion accompanying our projection that the sales data without weather-normalization can be explained reasonably well and thus there appears to be no reason for further adjustment of the recorded data.

[7/] Documentation is provided in (10).

Finally, the SCE estimates use only data from 1965 to 1973. There is no theoretical justification for choosing this particular time period. In an attempt to reconstruct the SCE model, Commission staff made estimates of the basic SCE first-difference model and the results are presented in equation (1) of Table 2.[8/]

The results in equation (1) indicate that the model may not be well specified for the 1965-73 time period because the R^2 is only 0.26. The results for equations (1)' and (1)'', however, indicate that the first-difference model has no explanatory power for the 1965 to 1974 or 1960 to 1974 periods when original data are used. Since first-differencing to eliminate a linear trend component makes sense only under the assumption that the first-order autocorrelation coefficient is unity, a necessary first step is to begin with a test of that assumption. To conduct this test, which SCE appears not to have done in connection with their base sales forecasts, we estimated the equations in their original form using ordinary least squares techniques and then reestimated them using the Cochrane-Orcutt method of estimation. These equations were estimated over the entire 1960 to 1974 time period on the assumption that all available data should be used.

The results in equations (2) and (2)' indicate that while ordinary least squares provide a good explanation of sales using employment and real disposable personal income as independent variables, the presence of autocorrelation does affect the results: ρ = 0.66 which is significantly different from zero and from unity. After adjusting for autocorrelation in equation (2)' the employment variable is no longer statistically significant, while the disposable

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[8/] All other equations referred to in this section were estimated by Commission staff and are also listed in Table 2.

TABLE 2

ANALYSIS OF SOUTHERN CALIFORNIA EDISON FORECASTING EQUATIONS

Dependent Variable	Time Period	Constant	Independent Variables					R²	F	ρ		Durbin & Watson
			ΔEMPL	ΔCDY	EMPL	CDY	PR			(Ho: ρ=0)	(Ho: ρ=1)	
1. ΔRKWH	1965-73	774.50	- .93 (-1.42)*	117.66 (.98)				.26	8.37*			2.90
1'. ΔRKWH	1965-74	648.34	- .39 (- .24)	55.11 (.19)				.01	.00036			1.14
1". ΔRKWH	1960-74	623.73	- .44 (- .33)	70.08 (.29)				.01	.0006			1.16
2. RKWH	1960-74	-14,154.14			1.68 (1.54) *	208.68 (1.69) *		.98	293.9**			.62
2'. RKWH	1960-74	-14,288.59			.29 (.38)	407.66 (4.10) **		.99	594.00**	.66 (3.26)**	(1.68)*	1.83
3. RKWH	1960-74	-11,301.6				397.0 (22.69) **		.97	514.8**			.44
3'. RKWH	1960-74	-13,988.4				443.4 (12.07) **		.99	145.7**	.66 (3.25)**	(1.67)*	1.92
4. RKWH	1960-74	-15,696.15				438.83 (12.08) **	103.5 (1.30)	.98	293.9**			.64
4'. RKWH	1960-74	-12,740.35				435.01 (10.24) **	-38.83 (- .54)	.99	594.0**	.67 (3.41)**	(1.68)*	1.90

TABLE 2 (contd)

Dependent Variable	Time Period	Constant	Independent Variables				R^2	F	ρ		Durbin & Watson
			ΔGSP	GSP	PI	PC			(Ho: ρ=0)	(Ho: ρ=1)	
5. ΔIKWH	1965-73	631.06	42.60 (.68)				.06	.462			1.50
5'. ΔIKWH	1965-74	128.64	197.52 (2.57) **				.45	6.60 *			1.45
5". ΔIKWH	1960-74	118.73	195.55 (3.16) **				.45	9.99*			1.46
6. IKWH	1960-74	- 7,163.0		269.67 (30.52) **			.99	931.5**			.93
6'. IKWH	1960-74	- 6,569.5		260.31 (11.10) **			.99	123.2**	.61 (2.90)**	(1.85)*	1.47
7. IKWH	1960-74	- 4,999.8		262.53 (37.73) **	-177.95 (- 3.34) **		.99	594.0**			1.32
7'. IKWH	1960-74	- 5,425.9		268.29 (29.75) **	-181.25 (- 3.41) **		.99	594.0**	.24 (.903)	(2.94)*	1.87
8. CKWH	1960-74	10,580.2		256.97 (19.32) **			.97	373.3**			.51
8'. CKWH	1960-74	-12,101.6		274.18 (9.47) **			.98	87.68**	.65 (3.20)**	(1.72)*	1.28
9. CKWH	1960-74	-11,087.0		260.26 (10.91) **		16.32 (.17)	.97	194.0**			.54
9'. CKWH	1960-74	- 8,988.4		261.39 (8.17) **		-136.41 (- 1.76)*	.99	594.0**	.70 (3.70)*	(1.56)*	1.36

* Significant at 10% level with a one-tail test.

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NOTES TO TABLE 2

Definition of Variables

RKWH: Annual residential sales (millions of kwh)

IKWH: Annual industrial sales (millions of kwh)

CKWH: Annual commercial sales (millions of kwh)

ΔRKWH: $RKWH_t - RKWH_{t-1}$; where t represents the year.

ΔIKWH: $IKWH_t - IKWH_{t-1}$; where t represents the year.

GSP: California gross state product (in billions of 1958 dollars)

EMPL: Total California civilian employment (in thousands)

CDY: Total California disposable personal income (in billions of 1958 dollars)

PR: Average residential price in mills per kilowatthour (in 1958 dollars) i.e., total residential revenues divided by total residential kilowatt-hour sales.

PI: Average industrial price in mills per kilowatthour (in 1958 dollars) i.e., total industrial revenues divided by total industrial sales.

PC: Average commercial price in mills per kilowatthour (in 1958 dollars) i.e., total commercial revenues divided by total commercial sales.

ΔEMPL: $EMPL_t - EMPL_{t-1}$; where t represents the year.

ΔCDY: $CDY_{t-1} - CDY_{t-2}$; where t represents the year.

ΔGSP: $GSP_t - GSP_{t-1}$; where t represents the year.

DATA SOURCES

RKWH IKWH CKWH	Electric System Planning, System Forecasts 1975-1994, Southern California Edison Company, March 1973, Table VI-A. Page 50.

GSP EMPL CDY	Ibid, Table IV-B, Page 28.
PR PI PC	Answers to Interrogatories, Southern California Edison Company, July 24, 1975. Table II, Page 44, reported prices in current dollars deflated by the Consumer Price Index.

STATISTICAL DATA

ρ: Cochrane-Orcutt estimate of the first-order autocorrelation coefficient.

R^2: A measure of the goodness of fit of the estimated equation.

F: A statistic used to indicate whether the chosen variables explain the variance in the dependent variable.

Durbin-Watson: A small-sample test for positive autocorrelation.

income variable has become more highly significant. In other words, both variables are so highly correlated with a time trend that they are highly correlated with each other; i.e., multicollinearity is present and distorts the results of the model.

Since the results in equation (2) indicate that only one of the two independent variables is important, multicollinearity is removed in equation (3) by reestimating this equation with the employment variable removed. Disposable income is very highly significant in equation (3) (the ordinary least squares regression); equation (3)' indicates that autocorrelation is present here also because the autocorrelation coefficient of 0.66 is significantly different from zero and from 1: after adjusting for autocorrelation, disposable income remains a significant variable. The specification of equation (3). however, leaves something to be desired. At least one important variable has been omitted from consideration, namely the price of electricity.

Equation (4) contains the ordinary least squares regression estimates which includes the average residential price of electricity as an independent variable. Although disposable income remains significant, price is not a statistically significant variable; moreover, it has a positive sign. If correct, this positive sign implies that an increase in price will cause customers to buy even more electricity. However, these peculiar results appear to be the result of a combination of autocorrelation and use of price and residential consumption variables which may be too aggregated for sensitive measurement. After having adjusted for autocorrelation in equation (4)', disposable income becomes highly significant, and the price variable, although not significant, has the expected negative sign. The insignificance of the price variable in the residential sector may also be due to the fact that residential customers are not aware of the precise prices they are being charged or that they are relatively insensitive to price variation since expenditures on electricity represent a small portion of their total budget.

Industrial Demand Model

Industrial sales (S) are estimated from projections in real gross state product using the following first-difference model specification:

$$\Delta S_t = 159.38\ (\Delta RGSP_t) + 313.76$$

In spite of the important fact that 1974 industrial kilowatt-hour sales declined 5.3% from 1973[9/], 1974 data were not considered in the industrial demand equation.

Our own estimates for the first-difference equation are presented in equations (5), (5)' and (5)''. Once again, there is a substantial difference in the results depending on the period of estimation. In this case, however, the model has very low explanatory power for the 1965-1973 period ($R^2 = 0.06$) and a higher explanatory power ($R^2 = .45$) for the other two periods.

Following the analysis of the residential demand forecast above, the SCE equations have been estimated for the 1960-74 period using variables in their original form. The results in equation (6) and (6)' indicate that gross state product is highly significant in explaining industrial sales, even after adjusting for the presence of autocorrelation. This specification is inadequate, however, in that price does not appear as an explanatory variable. Consequently, the average price of electricity to industrial customers has been added to the equations;

9/ (10) [illegible] 43.

the results are presented in equation (7) and (7)'. Since the Durbin-Watson statistic is in the inconclusive range in equation (7), the Cochrane-Orcutt method of estimation was used. Equation (7)' indicates the first-order autocorrelation is not present in equation (7). Both gross state product and the industrial price are significant variables in explaining industrial sales.

Commercial Demand Model

The model for commercial use of electricity was specified in the following estimating equation:

$$\Delta U_t = 13617.9\ (\Delta F_t) - 1826.0$$

The one independent variable (F) is defined as the weighting of three independent variables: (1) real gross state product lagged one year, (2) real disposable personal income lagged one year, and (3) total California employment.[10/] Using the variables in their original form, Commission staff re-estimated the commercial demand equations. Commercial sales are explained for the 1960-74 period using only gross state product as an independent variable in equation (8) and (8)'. The results indicate that gross state product is a highly significant variable even after adjusting for significant autocorrelation. Finally, equations (9) and (9)' present the results of adding the average price to commercial customers as an independent variable. The peculiar results for the price variable (insignificant, positive sign) disappear after adjusting for autocorrelation. Both price and gross state product are statistically significant in explaining the levels of commercial sales.

10/ The specific weighting scheme for the independent variables can be found in (13).

Data

SCE has presented historical data on the average price of electricity for residential, industrial and commercial customers from 1960 to 1974, on the rate schedules for major customer categories from 1964 to 1974,and historical and projected data on the independent variables specified for most of their base forecasting equations. Historical data on the variables used in their price elasticity study are available only for the average price of electricity, but such data is not presented according to rate schedule category. However, the remaining historical data by rate schedule category for major customer categori on the prices of natural gas,kilowatt-hour sales, and the number of customers and on the index of the capital stock for industrial customers, disposable personal income per household are not presented; these data were utilized in the price elasticity study estimations. A summary of SCE data is given in Table 3.

Conservation

In addition, the effects of conservation are not incorporated into the model directly; rather, they are included via "adjustments" to the base forecast previously constructed. In addition, these conservation adjustments are inextricably lumped with the price elasticity effects and there is some question about the precise interpretation of this approach. Because the SCE model does not capture the separate impact of conservation effects, there appears to be little justification for using this method.

SCE emphasized that conservation effects are to be found in the price effects in their model: "We assumed that the voluntary conservation in our forecast period

TABLE 3

Variables	Comments	Variables	Comments	Variables	Comments
Price Variables:		Demographic Variables:		Income & Business Activities Variables:	Historical data reported; source not specified
Average Price of Electricity	Historical data reported in interrog. response. Projections not reported.	Birth Rate	Historical data reported; Source not specified. Projection of 1.8 - 2.1 per woman. Basis for projection not reported.	Gross Nat'l. Prod.	
Marginal Price of Electricity	Historical data not reported. Projections not reported.	Migration Rate	Historical data reported; source not specified. Projection of 100,000/yr. for State based upon Department of Finance projections.	Gross State Product	Historical data reported; source not specified. 2.9% annual growth rate based on assumptions re productivity changes, etc.
Price of Natural Gas	Historical data not reported. Projections not reported.	Population	Historical data reported; source not specified. Projection of 1.2 - 1.3% annual based upon Cohort-component model.	Real Disposable Personal Income	Historical data reported; source not specified. Projection of 2.9% annual growth by assuming RDPI ∝ GSP.
Data	Cross section Time series 1963-74	Pop - Customer Ratio	Historical data reported; source not specified. Projection of 3.01 - 2.78 per customer. Basis for projection not reported.	Employment	Historical data reported; source not specified. Projection of 1.7% annual growth rate. Basis not reported.
				Business Indices	Apparently not used.

would be made by our customers based on economic judgment, and hence would be captured by a price model."[11/] However, in defense of omitting 1974 data from the estimation period, it was stated that 1974 data "included one-time conservation impacts (patriotic and mandatory) not represented by the model."[12/] If the forecasting model does indeed incorporate conservation effects via price effects, then the voluntary conservation impacts in 1974 would be imbedded in price effects in 1974 and, consequently, are represented in the model.

It should be pointed out that the effects of mandatory conservation and the effects of price should be separated since they are quite different. That is, conservation efforts in general will result in a decrease in demand and thus will tend to reduce both the price and the quantity demanded. These effects are quite distinct from the effects resulting from a change in the price alone, which only affects the quantity demanded. Adequate consideration of conservation effects entails the introduction of a different, more detailed approach to fully capture the conservation impact on the quantity of electricity demanded as well as on the price of electricity.

Price Elasticity

Because SCE is the only utility that conducted its own estimate of price elasticity, it is interesting to include a review of the methodology used; a good insight is given in a 1974 SCE study. [13/] This study had two major objectives: (1) to estimate price and cross-elasticity coefficients by major customer class and (2) to use these coefficients in a long-range energy forecast model. The study made use of data collected within the Edison service territory for the residential, industrial, and commercial sectors. In order to estimate the elasticities, of course, it is necessary to have a sufficient number of observations, so the Edison study combined information on usage and price from different rate schedules over time. There were sufficient changes in each rate schedule so that a pooling (combining) of these observations was feasible. [14/]

The price variable used in the elasticity estimates consists of the average pri in a customer category; i.e., total revenue in the category divided by total sales in the category. The study recognizes that there is a major controversy concerning the appropriate specification of the price variable:

> A major part of the problem in analyzing the impact of rate increases on kilowatt-hour sales is defining the price variable. Do customers respond to rate increase via average price, marginal price, or higher monthly bills? Elasticities are greatly influenced by the definition of the price variable and model. [15/]

The elasticity study chose the average price variable instead of a marginal price variable for three reasons: first, it is claimed that normalizing for weather would reduce the bias resulting from average price; second, obtaining the estimates via a pooled cross-section and time series model would also

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[11/] (2) p. 100

[12/] (13)

[13/] (17)

[14/] In the absence of a sufficient price variation within a given rate class, of course, making an elasticity estimate within SCE's service territory would be difficult considering the absence of reported information on detailed characteristics for each customer within the service territory. To get an idea of the total number of observations available using this procedure, there are a total of 18 different domestic rate schedules prevailing at any moment in time. Rate changes occurred for these schedules in 1964, 1965, 1969, 1970, 1971, and 1973, and every three months since May 1972 for fuel cost adjustments. SCE claims that a sufficient number of observations on price exists to allow calculation of the elasticity. (17) p. 19

[15/] *ibid*, p. 23.

provide more reliable estimates; and **third**, the forecast model in which the elasticity coefficients were to be entered consisted of a forecast of average price for gas and electricity.

It is interesting to note, however, that one of the reasons provided as an explanation for avoiding the use of marginal price is that customers themselves are unaware of marginal prices. "Many customers are not aware of the block structure of their rates, and are conscious only of the size of their monthly or bimonthly bill." [16] One of the principal reasons that this is the case, of course, is that customers are not provided the information on their monthly bills to allow them to calculate marginal rates, as is recognized by the SCE study. "Bills itemize only the total kilowatt-hours and not the usage by block." [17]

SCE states that their elasticity-estimating model is a "combined cross-sectionally heteroscedastic and time-wise autocorrelated model." [18] (Incidentally, in view of their familiarity with the use of Cochrane-Orcutt techniques to remove autocorrelation from time series data, it is rather surprising that the appropriate tests on the autocorrelation coefficient were not performed in connection with the forecasting model presented in their submission.) The equations estimated for the three sectors in this study are described below. First, kilowatt-hour usage per residential customer is a function of the price of natural gas, the price of electricity, and a variable called personal income per household. This specification appears to be quite appropriate; however, there is some question about how personal income per

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[16] (17)
[17] ibid, p. 23
[18] ibid,

household was obtained. This income variable was derived from California real disposable personal income divided by the number of residential customers. However, in view of the remark which refers to California real disposable personal income divided by the total number of residential customers as a "surrogate" for disposable personal income per household, it does not seem that the disposable income per household variable was defined in a similar manner. No explanation is provided concerning its derivation.

Second, industrial kilowatt-hour sales is defined to be a function of the number of industrial customers, the price of electricity to industrial customers, the price of natural gas, and an index for the capital stock. This specification also appears to be appropriate.

Finally, the equation used in the commercial sector takes the following form: kilowatt-hour sales per commercial customer are defined to be a function of the price of electricity, the price of gas, and a variable defined as a surrogate for disposable personal income per household, namely California real disposable personal income divided by the total number of residential customers. This specification, in contrast to the others, does appear to be somewhat unusual. It is not clear why disposable personal income per household should be an important variable in the commercial demand for electricity. Economic theory indicates that the commercial demand for electricity is derived from the demand for the output of commercial firms. Some measure of output, such as gross state product or commercial sales revenue should be used.

The data used to estimate the residential equation is described as consisting of monthly observations pooled over a ten-year period from rate schedules D-1 through D-6, D-1E through D-6E, and D-1M through D-6M;[19] thus providing 18 cross-sectional observations with 18 different rate levels which changed as the result of eight general rate cases and nine fuel cost adjustment cases. The data used to estimate the industrial equation was obtained by pooling annual data on 25 industries for the years 1964 to 1973. The data used in estimating the commercial equation consisted of monthly data for large and small commercial customers; i.e. those over and under 500 kilowatts monthly billing demand. Cross-sectional pooling of these different rate schedules (A-1 through A-6 and A-7 through A-8) for commercial customers was not performed due to the extreme diversity in size and characteristics of the two commercial customer classes.[20] Since these elasticities were obtained through time series rather than cross-section analysis, they are regarded as estimates of short-run rather than long-run elasticities.

There are a number of comments which are in order concerning the study of price elasticities made by SCE. The study indicates that there are two ways of incorporating prices into long-range energy forecasts. The first consists of "using a price variable directly in forecasting equations" and the second consists of "applying a price adjustment factor to a base case."[21] The only explanation we are provided for not using the first of these two methods is: "A possible shortcoming of this methodology is its inflexibility to adapt to wide ranges of possible scenarios."[22] This explanation, however, is inadequate. First the shortcoming is described as only a possible shortcoming. Second, we are not

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[19] (17) p. 39

[20] ibid, p. 44.

[21] ibid, p. 58.

[22] (17) p. 58.

told why this method is "inflexible." In fact, just the opposite appears to be the case. By having a price specified in the forecasting equation, it is possible to make various alternative assumptions regarding the behavior of future prices for the purposes of forecasting demand. In fact, this appears to be a more reasonable course of action than the two-step process chosen in the study; namely, to determine price elasticities in one equation and only then to arrive at the impact of price changes on demand in another equation called a "forecasting equation" which has no price variable.

The equations for two of these sectors do appear to be well specified. Price is incorporated explicitly as an independent variable in all three equations. The basic question is why the equations themselves were not used for the purposes of forecasting. No adequate explanation is provided for not having chosen that course of action. (The statistical results presented in Appendix D indicate that the independent variables are highly significant in nearly every case and that the R^2 is quite high.) A more fundamental criticism, however, concerns the purpose of forecasting prices and their impact upon sales.

In a true simultaneous equations framework one is not primarily concerned with forecasting prices. Rather, one is concerned primarily with identifying those exogenous variables on the demand and the supply side which will cause changes in future electricity prices. The inclusion of prices as independent variables, even in the ERCDC staff's reestimated equations, demonstrates by itself the absence of any supply side to the model. Ideally, the future prices are not

SUMMARY OF SCE FORECASTING MODEL

TABLE 4*

Customer Class	Model	Customer Class	Model
Model Specification & Method of Estimation:		Model Specification & Method of Estimation: (Contd.)	
Residential Customer Sales	Model specification: 1. $RCUS_T = POP_T/PCR_T$ 2. $ARU_T - ARU_T - 1 = a + b\ (RDPI_T - 1 - RDPI_T - 2)\ c\ (TE_T - TE_T - 1)$ 3. $TRU_T = RCUS_T \times ARU_T$ Method of estimation: regression.	Commercial	Model specification: 1. $CCUS_T = f(RCUS_T)$ 2. $ACU_T - ACU_T - 1 = a + b\ (GSP_T - 1 - GSP_T - 2) + c\ (RDPI_T - 1 - RDPI_T - 2) + d\ (TE_T + TE_T - 1)$ 3. $TCU_T = CCUS_T \times ACU_T$ Method of estimation: factor analysis.
Industrial	Model specification: $TIS_T - TIS_T - 1 = a + b\ (GSP_T - GSP_T - 1)$	Other Public Authority	$OPA_T = a + b\ TRU_T$ Method of estimation: regression
Resale	Resale $= a + b\ (TRU_T + TCU_T + TIU_T)$ Method of estimation: regression.	Conservation Effects	No explicit conservation measures listed; overall effects assumed captured in a conservation and price model.

* For a complete list of symbol definitions, see Table 1.

added as exogenous variables but are in fact derived from the simultaneous solution of supply and demand equations. The construction of a supply side to the model, of course, is one of the primary concerns of the Commission.

Further Considerations

Table 4 summarizes the Southern California Edison methodology. Their methods are the best among the major utilities in that they have explicitly identified the forecasting model that is used, the final equations and the major forecasting assumptions. Even so, significant ambiguities remain regarding the projected magnitudes of explanatory variables and their relations with energy loads.

For example, the major forecast assumptions are listed for a number of variables including population, economic, legislative, regulatory, technological, and energy resource variables but the equations estimated do not include all of these variables, and there is no indication that these variables were explicitly considered in the production of SCE's forecast.

One of the most important criticisms of the SCE methodology concerns the specification of the base sales forecasting model and the way in which price enters the model indirectly through price elasticity adjustments to the base sales forecast. The use of the first-difference technique is not appropriately justified; our own analysis indicates that estimation performed on Edison's own data in standard form does produce reasonable results provided appropriate adjustment to eliminate any linear trend is made.

SUMMARY OF SCE FORECASTING MODEL

TABLE 4
(Continued)

Customer Class	Model *	Customer Class	Model
Parameter Estimates & Confidence Statistics:			
Residential	$\hat{b} = 34.35$, $\hat{e} = .70$, $R^2 = .855$ (.62) (.25)		
Commercial			
Industrial	$\hat{b} = 159.38$ $R^2 = .887$ (3.12)		
OPA	$\hat{b} = .432$ $R^2 = .997$ (43.0)		
Resale	$\hat{b} = .077$ $R^2 = .987$ (153.)		

* Statistics refer to coefficients in equations listed on previous page.

Of course, this is not to suggest our revision of the SCE model is free of any shortcomings. Nevertheless, it indicates some of the improvements that might be obtained with the further application of recognized techniques.

Further, the price of electricity is not entered as an independent variable in the base sales forecast equation. Our analysis indicates that when price is entered as a separate variable it is negatively related to sales in the commercial and industrial sectors: the higher the price, the less is consumed. In addition, no justification is provided for not using the equations estimated in their price elasticity study to forecast base sales for major customer categories. Both the price of electricity and the price of natural gas enter these elasticity equations directly, together with such variables as an index of capital stock for the industrial equation and per household disposable income for the residential equation. Finally, although SCE apparently possessed sufficient data to enter both an average and a marginal price in their elasticity estimating equations in order to eliminate the bias in their estimates produced by using only average price data, only average price was actually used in their forecasting model.

Although the Southern California Edison forecasting report is superior in the sense that estimated coefficients and R^2 statistics are presented, the important Durbin-Watson statistic is absent from the base sales forecast equations. The statistical reporting is more complete for the price elasticity equations; the regression coefficients together with their t values are presented for each equation.

SAN DIEGO GAS AND ELECTRIC

Introduction

San Diego Gas and Electric (SDG&E) has furnished the Commission[23/] with an explicit description of the formal models used to forecast electricity demand and a list of external factors which are used in their econometric model. Examination reveals that they did not consider price effects or conservation efforts in the model. Each is "strapped on" the model after the base forecast has been made.

The external factors used in the base forecast are:

1. California disposable income;
2. Gross national product;
3. San Diego County population; and
4. Number of domestic customers.

Where noted, these variables are lagged to represent their continuing effect over time.

SDG&E also lists a number of variables which are not included in the econometric model but which are thought to significantly affect the impact of economic variables. These include:

1. Shortages of electric generating capacity;
2. Shortages of fuel;

[23/] (9)

3. Development of electric mass transit in San Diego;
4. Rapid industrial development; and
5. New technologies.

The economic variables are used to produce separate forecasts for three customer classes: 1) residential, 2) commercial and industrial, and 3) other.

Residential Demand Model

Sales for the residential category are estimated from the number of residential customers and sales per residential customer. Each is a function of several variables:[24/]

Domestic customers = f (population, disposable income, population lag, disposable income lag)

Sales per customer = f (log of population, disposable income, lag of log of population, log of disposable income)

Neither price effects nor explicit conservation effects are included in SDG&E's determination of residential demand in the SDG&E service area.

Commercial and Industrial Demand Model

As with residential sales, the combination of commercial and industrial sales are

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[24/] The specific equations are quite lengthy and so are not included in this report. The detailed equations can be found in (12) pp. 9-10.

specified in a single equation model. The form is given below:[25]

Sales = f (population, gross national product, population lagged by six years, number of residential customers lagged by six years, DUMMY)

Note that a dummy variable is included in this demand model. This approach often is used in statistical models in order to pick up some of the unexplained variance in the estimated values. Their successful use of a dummy variable in their regression analysis confirms their hypothesis that there was a basic change in the relationship between commercial sales and the independent variables.[26] However, no attempt is made to explain how or why this change might have occurred.

There is also some question about the inclusion of population and number of residential customers in a model for commercial demand for electricity. An attempt should have been made to explain this choice of independent variables.

Still another major shortcoming of the SDG&E commercial demand model revolves around inclusion of the industrial sector as well. In defense of this unorthodox econometric approach, SDG&E indicates that their service territory is not heavily industrialized.[27] In using this approach, they are implicitly assuming that their service area will remain unindustrialized and that the same factors which determine commercial demand will also fashion industrial demand.

25/ As in the case with the residential demand model, the related equations are not included in this report, but can be found in (12) pp. 9-10.

26/ (9) p. 33.

27/ *ibid.*, p. 136.

"Other" Sales Model

The remaining sales are grouped together into a constant sales factor. Included in this category are such diverse accounts as agriculture and street lighting. The constant sales factor is the average (200 million watt hours per year) of all nonresidential and noncommercial sales over the historical period.

Data

Table 5 is a summary of the SDG&E submissions. While all data used in developing the forecast is presented, it is important to note that the time series analysis was performed only on data for the years 1956-1972. SDG&E is the only utility which uses just the 1956-72 period. Because the use of different time periods will cause changes in demand forecasts, the reasons for choosing this particular period should be carefully examined.

Conservation

The SDG&E report indicates that 1973-1975 data in the SDG&E service area were reviewed for each customer category and that a short-range forecast covering the period of 1975-1976 was prepared based on the results of this detailed conservation analysis. This short-range forecast is intended to reflect the utility's

SUMMARY OF INDEPENDENT VARIABLES IN SDG&E FORECASTS

TABLE 5

Variables	Comments	Variables	Comments	Variables	Comments
Price Variables:		Demographic Variables:		Income & Business Activities Variables:	
Average Price of Electricity	Historical data reported. Projections not reported.	Birth Rate	*	Gross Nat'l Prod.	Historical data reported; source not specified. Projection of 4.1% annual growth from UCLA study.
Marginal Price of Electricity	Historical data not reported. Projections not reported.	Migration Rate	*	Gross State Prod.	*
Price of Natural Gas	Historical data not reported. Projections not reported.	Population	Data reported; source not specified. Projections based upon Dept. of Finance D-100 series.	Real Disposable Personal Income	Historical data reported; source not specified. Projections based on UCLA study.
End Use Variables:		Pop - Customer Ratio	*	Employment	*
Appliance Saturation	*				
Data	Time series 1956-72			Business Indices	

*Apparently not used.

best data on current conservation efforts. When compared with the forecast produced by the econometric model, which does not include the effect of conservation, the difference between the two, which amounts to 16.2% for 1976, is attributed primarily to the effect of conservation. The forecast generated by the econometric model for every other year is then adjusted by this 16.2%; the result is an SDG&E forecast which includes conservation effects at least crudely. Implicit assumptions in this approach are: 1) that real electricity prices will not change significantly over the next ten years, and 2) that new conservation efforts will have no greater effect than past efforts. In the face of recent price increases and potential future price increases as well as the conservation mandates of the Energy Commission, these assumptions are questionable at the very least.

Another major problem with the SDG&E conservation model is that price and conservation effects are included together in the 16.2% adjustment to the base forecast. Using this method, conservation effects not motivated by price and price effects are unalterably fused: the effects of explicit conservation actions cannot be separated from reductions in the amount of energy consumed due to increases in price.

For the reasons given above, the model as specified could not be used for policy analysis.

Further Considerations

The SDG&E methodology summarized in Table 6 does represent an improvement over that used by LADWP or PG&E: a regression model is used, a single equation is

SUMMARY OF SDG&E FORECASTING MODEL

TABLE 6

Customer Class	Model	Customer Class	Model
Model Specification & Method of Estimation:		Model Specification & Method of Estimation: (Continued)	
Residential Customer Sales	Model specification: 1. $RCUS_T = a + b\ POP_T + c\ RDPI_T + d\ LGPOP_T + e\ LGPI_T$ $\hat{b} = 4.9$, $\hat{c} = 1987.8$, $\hat{d} = 1.6$, $\hat{e} = 10302.9$ 2. $ARU_T = a + b\ POP_{T-6} + c\ RDPI_T + d\ LGPOP_{T-6} + e\ LGPI_T$ $\hat{b} = .0014$, $\hat{c} = .000012$, $\hat{d} = .000078$, $\hat{e} = .000013$ 3. $TRU_T = RCUS_T \times ARU_T$ Method of estimation: regression.	Commercial	Model specification: $TCU = f(POP_T, RDPI_T, GNP_T)$ Method of estimation: principle components.
Industrial	Included in commercial model.	Other Public Authority	Assumed constant.
Resale	NA	Conservation Effects	No explicit conservation measures listed; overall effects assumed captured by price adjustments.

specified for each sales category, a list of independent variables is presented, and the data used to estimate the equations are furnished. Although the SDG&E methodology is superior in these respects, it still has several major shortcomings.

San Diego Gas and Electric encountered a problem in estimating their model: like SCE, they said multicollinearity affects their forecasts because all the variables are correlated with time. However, even if all but one of the independent variables were eliminated, there might still be a problem due to the time series nature of the data, i.e., autocorrelated disturbances. As noted in this report under 'Statistical Rigor," a commonly accepted approach to handle autocorrelation is to use the Cochrane-Orcutt method for estimation, but SDG&E (1) introduced lagged variables, and (2) used what they termed "factor analysis."

Using the so-called factor analysis technique, the original independent variables are transformed using linear combinations of the independent variables. The first three principal components are chosen and the three categories of electricity demand are then regressed on the three principal components. **However, it** should be pointed out that principal component analysis **can essentially be dismissed** as a tool of econometric investigation.

The Durbin-Watson statistic should have been presented to demonstrate the presence of trend and the Cochrane-Orcutt method should have been used to eliminate any linear trend component. It should have been adequately demonstrated that multicollinearity did indeed present a problem. One approach would be to eliminate all but one of those variables highly correlated from the equation. This approach would at least have the advantage (in contrast to the factor analysis approach) of being able to isolate the effects of changes in the independent variables.

PACIFIC GAS AND ELECTRIC

Pacific Gas and Electric (PG & E) supplies 45% of all the electricity in California.28/ In spite of this responsibility, PG&E "does not presently utilize a 'formal or informal statistical model' to forecast energy. Statistical techniques, special information, and informed judgment all play a part in the preparation of the forecast." 29/ The statistical techniques apparently 30/ consist of an unspecified set of extrapolations of historical trends and regressions. The results of these analyses are modified to incorporate special information from market studies and other independent forecasts. The base forecasts obtained in this manner are further adjusted to account for the effects of energy conservation and other recent developments:

> These adjustments were based on the significant reduction of electric energy growth that has already occurred and on judgmental assessments of the net effect of continued energy conservation, oil and gas shortages, real price increases, new building code regulations, new appliance efficiency standards, and other conservation measures on future load growth. 31/

PG & E forecasts electrical sales for 17 separate classes of customers. Since sales in residential, commercial, and industrial categories account for 90% of the service area total, only those three classes will be discussed.

Residential Demand Model

The PG & E residential electric energy sales forecasts are based upon projections of energy use per customer, number of customers, and historical residential sales. PG & E uses a combination of time series analysis,

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28/ (19)
29/ (10) p. 7.
30/ (8)
31/ (10) p. 25.

current electricity use-per-customer factors and extrapolation of historical trends to make these projections. In arriving at a final base estimate, "informed judgment" regarding additional factors is used to modify the statistical results. The extent to which "judgment" nullifies the previous analytical efforts is not clear from the material PG & E submitted for the record. Average electrical sales are forecast by using time series analysis. Unfortunately, the equations are not specified in PG & E's written submissions or response to interrogatories.

The forecast of residential customer growth is based upon the Department of Finance D-100 series population projections, but, "judgment concerning new technological developments and economic conditions is factored into the selection of the final estimate." 32/ Finally, these base forecasts are adjusted to account for conservation and the effects of price changes. The basis for these adjustments is discussed below in more detail.

The residential sales forecast fails to specify the relationship between electrical consumption and the demographic and economic variables mentioned above. Neither does it make projections of the important economic variables which influence loads. Thus it is impossible to examine their impact or the sensitivity of the forecasts to changes in the projected magnitudes of load determinants. While the PG & E responses to the interrogatories indicate that projections of these variables are made and used in the preparation of the forecasts, "PG & E's forecast of total Area System energy is not specifically sensitive to any of the projections." 33/

32/ (10) p. 6
33/ (11) p. 20

Informed judgment plays a key role in at least three stages of the preparation of final numerical forecasts. First, modifications of extrapolation and trend analysis are made to consider economic conditions. Second, judgmental assessments of the impacts of price increases and conservation programs are used as the basis for adjustments in the base forecasts. Finally, the forecasts prepared by PG & E are reviewed by a committee of PG & E administrative personnel. In spite of the central role which judgment played in the forecasting procedure, there is little documentation of the magnitudes of these adjustments or of a justification for making the modifications. These failures make it impossible to evaluate the realism of the judgmental modifications.

Commercial Sales

The commercial sales forecast is similar to the residential sales forecast. The results of estimating equations are modified to consider "special information," and these base forecasts are further adjusted to incorporate the impacts of price increases and conservation programs. The specification of the estimating equations is not presented, nor are the coefficient estimates or tests of significance. PG & E made no response to the interrogatory which requested this information.

The submissions by PG & E do not provide the special information which was used as a basis for the modifications, not do they describe how they were incorporated.

Industrial Demand Model

Industrial sales are broken down into two components: refinery load and industrial balance. The estimating equations for time series and regression analysis are, like those for residential and commercial sales, not given.

Even if the equations were given, it is unlikely that they would be used in evaluating the model, for the resulting estimates are in some unspecified way "adjusted" again for other impacts. 34/

Data

Table 7 contains a summary of the data provided by PG&E. Because the PG & E submission does not discuss the projected magnitudes of load determinants, it is impossible to know whether other important variables were overlooked altogether, were intentionally omitted, or were not significant in the formulation of the forecasting model. The report does, however, reveal that time series data, where used, covers the period 1961 to 1974. 35/

Conservation

The base forecasts for each customer class were reduced to account for the impact of conservation programs and electricity price increases. The reductions are intended to incorporate the following elements:

1. Oil and gas shortages;
2. Industrial conversion from oil and gas to electricity;
3. Voluntary energy-saving measures;
4. Real price increases; and
5. Anticipated new mandatory conservation measures.

PG & E uses an interesting technique to determine percentage adjustments to account for price and conservation effects:

> A base forecast that excluded the estimates of these effects was made from a projection that was based on actual data through the third quarter of 1973. . . . Then we computed the percent difference between this base forecast and the significant reduction in actual load that had already occurred for the nine months of 1974. . . . Then based on these assessments, we estimated what these percent reductions would be for every year in the future for this forecast. 36/

34/ "The forecasts . . . are adjusted after considering the summaries of national, state and local economic reports and other detailed plans of specific customers that would have a significant impact on KWH sales." (8) p. 7

35/ (8) p. 26

36/ (4)

SUMMARY OF INDEPENDENT VARIABLES IN PG&E FORECASTS

TABLE 7

Variables	Comments	Variables	Comments	Variables	Comments
Price Variables:		Demographic Variables:		Income & Business Activities Variables:	
Average Price of Electricity	Historical data reported in interrogatory. Projections not reported.	Birth Rate	Historical data not reported. Projections not reported.	Gross Nat'l. Prod.	Historical data not reported. Projections not reported.
Marginal Price of Electricity	Historical data not reported. Projections not reported.	Migration Rate	Historical data not reported. Projections not reported.	Gross State Prod.	Historical data not reported. Projections not reported.
Price of Natural Gas	Historical data not reported. Projections not reported.	Population	Historical data reported. Source: Department of Finance, Report 74P-1. Projections based on Department of Finance D-100 series.	Real Disposable Personal Income	Historical data not reported. Projections not reported.
End Use Variables: Appliance Saturations	Historical data not reported. Projections reported; basis not specified.	Pop - Customer Ratio	Historical data reported: Source not specified. Projection of 1.0% annual decline. Basis for projection not reported.	Employment	Historical data not reported. Projections not reported.
Data	Time series 1961-74			Business Indices	Historical data not reported. Projections not reported.

In other words, PG & E attributed the reductions of actual loads in 1974 from earlier projections to the five considerations mentioned above. This figure was then applied to the long term base forecast. However, PG & E does not indicate explicitly the projected magnitudes of price increases or other factors. Neither does PG & E seem to recognize that future conservation savings are likely to be significantly greater than the relatively small reductions experienced in 1974. Therefore, it is impossible to evaluate the sensitivity of these adjustments to projections of these variables.

Further Considerations

As shown in Table 8, the current forecasting methodology of PG & E is based primarily upon the use of extrapolation of historical trends, regression analysis, and "informed judgment". No effort has been made to isolate the possible effects of the various independent variables. The report, in connection with efforts to estimate the effects of changes in electricity prices, business activity, and weather on electricity demand. claims that, "There is no way to isolate the effects of each of these factors." 37/ Use of the forecast methodology described by PG & E implies that historical growth patterns of output, population, and other variables such as the price of electricity and natural gas have been assumed to continue in the future. The historic pattern of growth in electricity use has changed significantly since late 1973. Factors which helped to produce these changes include a significant decline in output, higher real prices for electricity and natural gas, a natural gas shortage, and new energy conservation measures. These factors were not considered explicitly in the projection and would probably change the projections if included.

Furthermore, there are some questions about the projected aggregate growth rates chosen. For example, the projection of residential electricity use to

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37. (8) p.4

SUMMARY OF PG&E FORECASTING MODEL

TABLE 8

Customer Class	Model	Custome Class	Model
Model Specification & Method of Estimation:		Model Specification & Method of Estimation: (Contd.)	
Residential Customer Sales	Model specification not reported Method of estimation: regression Note: PG&E states that it uses no "formal or informal statistical model"	Other Public Authority	No model
Commercial	Model specification not reported Method of estimation: regression Note: PG&E states that it uses no "formal or informal statistical model"	Resale	No model
Industrial	Model specification not reported Method of estimation: regression Note: PG&E states that it uses no "formal or informal statistical model"	Conservation Effects	No explicit conservation measures listed; overall effects assumed captured by price adjustments.

1980 results in a sizeable increase in usage per customer; 38/ however, if stringent requirements for structural insulation and improved appliance efficiency are implemented by 1977 (as is required by the Energy Commission) one can show that the amount of residential electricity used per customer would increase at a substantially slower rate.

In short, the forecasting methodology used by Pacific Gas and Electric cannot be thoroughly evaluated because the relationships among the independent variables and their relation to the dependent variable have not been fully indicated and the method of estimation has not been presented. In addition, there is reason to believe that the PG & E judgmental forecast may be based on questionable assumptions.

38/ PG & E projects the average annual compound growth rate in average sales per residential customer to be 4.3% from 1975-1980, yet this growth rate has been declining from +4.9% in 1961-65 to -2.5% in 1973-74. (8) p.31

LOS ANGELES DEPARTMENT OF WATER AND POWER

Introduction

The Los Angeles Department of Water and Power (LADWP) forecast of annual electrical sales is based on extrapolation of the factors that they believe have affected historical loads.[39/] These factors include:

1. Population;
2. Business activity;
3. Employment;
4. Real income;
5. Real cost of electrical energy; and
6. Pollution restrictions.

A breakdown of the variables used is given in Table 9.

LADWP asserts that:

> although...The historical relationships cannot be used directly in developing load projections, they do provide a basis for explaining historic growth. To the extent that projections of future trends of these factors are available, they are helpful in developing assumptions on which future load projections may be based. 40/

The assumptions about the short-run (1975-80) magnitudes of these factors are:

1. Increased implementation of insulation and appliance efficiency standards;
2. Population projected to be 2,880,000 in 1980;
3. Normal economic growth over the period to 1980;
4. Rising real cost of electricity;
5. Reduced availability and higher price of natural gas; and
6. Changes in residential and industrial patterns.

39/ (7)
40/ ibid, pp. 6-7.

TABLE 9

Variables	Comments	Variables	Comments	Variables	Comments
rice Variables:		Demographic Variables:		Income & Business Activities Variables:	
Average Price of Electricity	Historical data reported in Summary Table. 0-4% annual increase projected.	**Birth Rate**	Apparently not used	Gross Nat'l. Prod.	Apparently not used
Marginal Price of Electricity	Historical data not reported. Figures not projected.	**Migration Rate**	Apparently not used	Gross State Prod.	Apparently not used
Price of Natural Gas	Historical data not reported. Figures not projected.	**Population**	Historical data reported in Summary. Projections based upon City of L.A. Planning Department.	Real Disposable Personal Income	Historical data reported. Projections not reported.
End Use Variables:					
Appliance Saturation	Reported in answers to interrogatories.	**Pop - Customer Ratio**	Apparently not used	Employment	Historical data reported; source not specified. Projections not reported.
Data	Time series 1959-1974			Business Indices	Historical data reported in Summary. Projections not reported.

In the long-range forecast from 1980 to 1990, the following additional considerations are also indicated to be important:

1. Conversion of some existing natural gas uses to electricity;
2. Modernization of existing industrial plants; and
3. Redevelopment of older areas of the city.

LADWP applies these assumptions in an unspecified manner to arrive at load forecasts. The forecasts project a constant annual growth of 700 gigawatts per year from 1976-80 which in itself is suspicious. In 1981 the loads are forecast to rise dramatically and to grow at an increasing rate thereafter. There is no explanation of why the demand growth should be exactly constant for five years and then suddenly rise in 1981.

Forecasting Methodology

In its Answers to Written Interrogatories submitted after the draft ERCDC staff report had been issued, LADWP discussed the procedures by which its forecasts were developed. While the lateness of their submission precluded a detailed analysis of the LADWP methodology, some observations are possible.

According to the LADWP, total net energy load for the service area was projected from regression equations whose parameters had been estimated using 1959-1974 data. The independent variables in the estimating equation were 1) City of Los Angeles population, 2) Security Pacific Bank's Index of Business Activity, and 3) average price of electricity for all customer classes in 1967 dollars.[41/] The estimated coefficients were all highly significant. The estimation results are summarized in Table 10. Using the estimating equation, forecasts were made from projections of values of the independent variables. Population projections were obtained

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[41/] (19) p. 3

SUMMARY OF LOS ANGELES DEPARTMENT OF WATER AND POWER FORECASTING MODEL

Table 10

Customer Class	Model
Model Specification & Method of Estimation: Total Sales	Total Sales = $b_0 + b_1$ POP + b_2 BUS. INDEX + b_3 PRICE Method of estimation: regression
Parameter Estimates & Confidence Statistics: Total Sales	$\hat{b}_0 = -.01732$ $\hat{b}_1 = .26897$ (4.245) $\hat{b}_2 = .57193$ (11.832) $\hat{b}_3 = -.28609$ (-9.101) $R^2 = .997$, F = 1500, D.W = 1.54
Conservation Effects	No explicit conservation effects given.

from the City Planning Department. The real price of electricity is assumed to rise at an annual rate of 4% from 1977 to 1980. Business activity is projected to grow at an annual rate of 8% for the same period. For subsequent years the values of the independent variables are not given. However, LADWP explains the renewed surge in electrical load growth in terms of the "declining availability of natural gas." Unfortunately, "a quantitative assumption concerning the effect of natural gas shortages on electrical load growth was not made. Qualitative assumptions were made which affected judgmental decisions concerning the load forecast."42/

LADWP makes several qualitative assumptions about the future economic conditions in its service area. However, it does not project the numerical values of these variables nor does it indicate the sensitivity of its load forecasts to the projections of these factors. It is, therefore, impossible to isolate the impact upon electricity loads of any single determinant. Moreover, LADWP, in oral testimony, indicated that it does not project sales either by customer class (residential, commercial, industrial) or by end use. Such disaggregation would appear essential in determining the impacts of assumed changes in residential, commercial and industrial patterns.

Data

In the Answers to Interrogatories, LADWP presented the historical data used in its estimating equations. The projected values for the independent variables can be inferred from their remarks for 1975-1980. However, projections are not given beyond 1980. The higher projected electricity prices are justified based upon the assumption of reduced natural gas availability. However, the price of natural gas is not projected.

42/ ibid, p. 6

Conservation

The LADWP forecasts assume that some residual effect of the mandatory load curtailment program will dampen load growth in the near term. Further,

> It is believed that during the period through 1980 a national conservation effort will continue and requirements for additional insulation of new structure and improved efficiency of appliances and electrical equipment will be imposed... Conservation efforts will unquestionably have an impact on load growth during this period. 43/

These conservation factors were incorporated into the forecasts in the following way: first, LADWP assumes that 50% of the "load that customers curtailed to meet the requirements of the curtailment program will not be recovered" and second, judgments were made in developing the forecasts and "input to that judgment was the fact that there would be continuing conservation on a volunteer basis in the short term and resulting from actions of the Commissions..."44/

With respect to the effects of conservation, the Commission requested that LADWP submit a detailed explanation of how conservation effects are included in the projections, along with all assumptions and identification of where judgment is used and the basis for that judgment.45/

To date, LADWP has failed to respond to that request.

Further Considerations

Given that LADWP response to ERCDC interrogatories was late, it is impossible to conduct a detailed evaluation of their methodology. The most evident deficiencies in the LADWP model involve the failure to disaggregate sales projections by customer class and the omission of projections of the independent

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43/ (7) p. 12
44/ (2) p. 67
45/ ibid, p. 68

variables for the entire forecast period. Additionally, LADWP has noted some problems regarding the inclusion of Security Pacific's Business Activity Index in the estimating equation. LADWP has indicated that it is in the process of modifying its forecasting procedures, and hopefully these problems will be addressed.

THE CALIFORNIA PUBLIC UTILITIES COMMISSION
TEN-YEAR LOAD FORECAST

Introduction

The California Public Utilities Commission (CPUC) issued their General Order 131 in 1971. This general order promulgates rules relating to the planning and construction of facilities for the generation of electrical power and its transmission. The Commission's latest forecast report states that the objective of this rule was to "protect the environment and to better carry out the Commission's responsibility to promote the safety, health, and convenience of the public and to regulate electrical public utilities in the public interest."[46]

General Order 131 requires California electric utilties to file a ten-year forecast of loads and resources. This section will analyze the CPUC report of their forecasts and its relationship to the electric utility company forecasts submitted to them under General Order 131.

Energy Requirements

Section A of the CPUC report tabulates the "historical energy requirements" for California for the ten years prior to the forecast. The report then details the sum of the major utilities' forecasts for the years 1975, 1978, 1981, and 1984; the related energy requirement growth rates; the staff energy forecasts of requirements and growth rates for the same years; and a comparison with the public utility forecasts.

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[46] (19) p.1.

In a limited discussion of methodology, the report states that, "The staff considered population and net migration forecasts of the State of California Department of Finance in making these estimates of energy requirements."47/ In a footnote it is indicated that the series D-100 was used. This statement represents the total analytical discussion of Section A of the CPUC report.

Table 11 illustrates the CPUC and utility projections for consumption in juxtaposition with the weighted average price developed by ERCDC. In addition, this table illustrates the variation in percentage increase of electricity use and price.

Notice that the annual percent increase in actual requirements for the years 1970 through 1974 varies drastically: the 1970 through 1971 percent increase was over 6%, while the 1973 to 1974 percent change was a decrease of almost 3%. In the face of this rapidly decreasing growth rate for the years 1972 through 1974, the CPUC projects an overall growth consumption rate of 4.7% from 1975 through 1984. A cursory examination of these data indicates that noteworthy changes may have occurred and that a more extensive analytical effort is required than appears to have been applied by the CPUC.

Trends in Load Factor

The CPUC report notes that the utilities calculate annual load factors based only

Table 11
Utility and CPUC Projected Requirements
(Millions of Kilowatt-Hours)

Year	Utility Co. Requirements Forecast (Million KWH)	Annual Percent Change	CPUC Requirements Forecast (Million KWH)	Percent Increase	Weighted Average Price (Mills per KWH)	Percent Change
1965	94,855	--	--	--	16.4	--
1966	103,989	9.63	--	--	15.9	-3.0
1967	110,990	6.73	--	--	15.2	(-4.4)
1968	119,746	7.89	--	--	14.4	(-5.3)
1969	126,807	5.90	--	--	13.6	(-5.6)
1970	134,353	5.95	--	--	13.0	(-4.6)
1971	142,464	6.04	--	--	13.2	1.5
1972	152,878	7.31	--	--	13.4	1.5
1973	157,681	3.14	--	--	13.2	(-1.5)
1974	153,088	(2.91)	--	--	16.4	24.2
1975	160,8001/	5.04	162,200	5.95	29.9	82.3
1978	187,800	5.31	188,100	5.06	31.5	5.4
1981	219,100	5.27	215,400	4.62	32.1	1.9
1984	257,600	5.54	245,300	4.43		

1/ Based on data from pages 2-5, CPUC Report, May 1975.

2/ Prices are in 1958 dollars, and are weighted by sales figures submitted by PG&E, SCE, and SDG&E to ERCDC.

47/ ibid., p. 2.

on minor variations in system operation and that the load factors "all fell in 1974, reflecting the effects of conservation on energy sales." 48/ The CPUC report gives no further analytical justification for this statement of causality; the report makes no serious attempt to determine the long run significance of this decrease. The report further states that:

> System load factors are expected to continue to decrease gradually for several years, reflecting the continuing effects of reduced usage growth and the addition of more efficient appliances, which are expected to reduce energy sales but have little effect on peak demand. After 1980, load factors are estimated to remain constant. Any deterioration in load factor, for the above stated reasons, tend to be offset by potential changes in rate design, such as peak load or end-use pricing. 49/

This statement represents the total analytical justification for their assumed load factors. The overall load factor for the California utilties did decrease in 1974, but the CPUC forecast implicitly indicates that the load factor returns to 61% in 1975 and then resumes its slight downward trend for the remaining projected years, as can be seen in Table 12.

The CPUC data for historical peak summer demands, the utilities' peak demand forecasts, and the CPUC staff peak demand forecasts are displayed in Table 13. The implicit growth rate in the utility company projections, from the 1974 base through 1984, is 5.5%, while the corresponding growth rate implicit in the CPUC forecast is 4.9%.

48/ ibid., p. 6.
49/ ibid., p. 6.

TABLE 12

HISTORICAL AND CPUC FORECASTS

Historical and CPUC Forecasts

Year	Peak Summer Demand 1/ (Megawatts)	Requirements (Millions of Kilowatt Hrs)	Load 2/ Factor
1970	23817	134353	64.4
71	26470	142464	61.4
72	28231	152878	61.8
73	29046	157681	61.9
74	29356	153088	59.5
75	30340	162200	61.0
78	35840	188100	59.9
81	41460	215400	59.3
84	47350	245300	59.1

1/ Based on data on pages 7 and 9, CPUC Report, 1975.

2/ Computed by ERCDC staff by first dividing consumption by 8,760 hours per year and again by peak demand.

Table 13: Utility and CPUC Projected Peak Summer Demands (Megawatts)

Year	Utility Co. Peak Summer Demand Estimate (Megawatts)	Percent Change	CPUC Peak Summer Demand Estimate (Megawatts)	Percent Change
1970	23817	-	-	-
1971	26470	11.14	-	-
1972	28231	6.65	-	-
1973	29046	2.89	-	-
1974	29356	1.07	-	-
1975	30930[1]	5.36	30340[1]	3.35
1978	36490	5.66	35840	5.71
1981	42600	5.30	41460	4.97
1984	50100	5.55	47350	4.53

[1] Based on data from pages 7-9, CPUC Report, May, 1975.

Loads and Resources

The CPUC report, in Table 2 of Appendix A, shows the historical loads and net resources, after scheduled and unforeseen maintenance, for the year 1972, 1973, and 1974. Table 3 of Appendix A gives the estimates of these quantities, after scheduled maintenance and assuming "adverse water conditions" for the years 1975, 1978, 1981, and 1985. The data from these two tables are combined into Table 14 below. They were not developed under the same assumptions, however, so that no general conclusions can be drawn.

TABLE 14

PEAK DEMAND AND NET PLANNED CAPACITY

Year	Actual and Projected "Load"1/* (Megawatts)	Net and Planned Resources1/ (Megawatts)	Percent Net Margins
1972	27,819	31,382	12.8
1973	28,684	31,353	9.3
1974	28,957	33,431	15.4
1975	30,341	38,291	26.2
1978	35,816	43,523	21.5
1981	41,828	48,985	17.1
1984	49,193	57,342	16.6

*1/ Figures are derived by CPUC by summing the utility's estimates as given in Tables 2 and 3 of Appendix A.

Projections of Sales per Customer

The electrical sales per customer were forecast from recent historical data. For the year 1975 sales projections were based upon the sales figures for 1973 and 1974. The CPUC examined the decline in sales from 1973 to 1974 and compared the change with the level of sales for the last six months of 1974. Based upon these two figures, the CPUC assessed the degree to which electricity usage was recovering from the effects of the oil embargo. The resulting numerical forecasts of 1975 sales were almost equal to the recorded sales for 1973.

To forecast electricity sales growth for subsequent years, the "average per customer" growth rates were calculated for the period 1970 to 1973. These historical rates were deflated by a given percentage to arrive at the projections. The deflation factors varied among utility systems and customer classes. For example, in the PG & E service area, the historical growth rate was approximately 240 kilowatthours per customer per year; this figure was deflated by 25% to arrive at the projected growth rate for the PG & E area. On the other hand, the average annual growth rate in the SCE service area was 260 kilowatts per customer per year. This figure was deflated by 50% to achieve the projected growth per residential customer. 50/

The deflation factors were intended to capture the effects of the increased cost of electricity and other considerations. Unfortunately, the CPUC neither specified the basis for choosing those particular deflation percentages nor did it indicate the projected magnitudes of the factors expected to dampen electricity usage growth. Because of these omissions, it is impossible to evaluate the reasonableness of the projections or the sensitivity of the forecasted growth rates to any of the assumptions in the study.

Conservation

The CPUC forecast does not explicitly consider the effects of future conservation efforts in its forecast. It does assume that "change in building code requirements and other efficiency measures" will substantially offset the increased reliance upon electricity for heating. Unfortunately, the PUC forecast does not indicate either the expected increase in electrical heating saturation or the level or type of insulation and efficiency standards. Without this information, the assumption of offsetting effects cannot be adequately analyzed.

Further Considerations

The CPUC characterizes their methodology as "judgment applied to incremental parts of each utility."51/ For each service area and customer class the CPUC forecasters applied their subjective assessment of an unspecified set of factors upon recent historical growth rates. Nowhere can our staff find any substantive justifications for these judgments nor a complete statement of considerations and assumptions which were incorporated into the forecast. Further, there is no way of determining the sensitivity of the forecasts to alternative economic and demographic conditions in the State during the forecast period.

50/ (1)

51/ (1) p. 21.

In other words, the CPUC forecast is not based on an explicit methodology using commonly accepted analytic techniques. It is of interest to determine whether the CPUC could have based its forecast upon such a methodology, using only the data supplied to it by the utilities.

A Simple Forecasting Example

Economic theory indicates 52/ that sales to residential customers will be influenced by different factors than will sales to commercial plus industrial customers. 53/ The residential demand for electricity, like the consumer demand for any normal good or service, is expected to be influenced by the level of residential income; the higher the level of residential income, the greater the quantity of electricity expected to be consumed. The demand for electricity by commercial plus industrial customers, however, is more properly viewed as a derived demand for a factor of production; 54/ the greater the level of production, the greater the quantity of electricity expected to be used in the production process. The price of electricity, of course, is expected to affect both the residential and the commercial plus industrial demand for electricity. The higher the price, the lower the quantity of electricity expected to be consumed or used.

For purposes of this exercise the level of residential income may be measured by California disposable personal income while the level of output for the commercial plus industrial sectors may be measured by California gross state product. The price of electricity to the residential and commercial plus industrial sectors may be measured by the average price of electricity (revenues divided by sales) for each sector. Since both disposable personal income and gross state product data are reported by the utilities in 1958 dollars, all current dollar average prices were also converted to 1958 constant-dollar average prices.

52/ (26) pp. 11-45.

53/ Since SDG & E reported sales for the commercial and industrial sectors combined, these sectors were combined for the other utilities.

54/ For a discussion of derived demand theory, see (26) pp. 135-155.

Estimation was performed on the combined data reported by PG&E, SCE & SDG&E since only these three utilities reported the required data in time to be utilized for this report. 55/ The dependent variable in each equation is the sum of relevant sales reported by these three utilities; the price variable in each equation is the average of reported prices weighted by sales for each utility. The precise definition of the sales categories together with all the data used as input in the estimation process is provided in Appendix A. Estimation was performed, for the period 1960-1974. The results are presented in Table 15.

As is evident from Table 15, the price variable is significant in equations (1) and (2'). However, after adjusting for autocorrelation in equation (1), the price variable is not significant for the residential sector. 56/ This is consistent with our earlier findings for the SCE service area, reported in Table 2, in which price was not significant for the residential sector but was significant for the commercial and industrial sectors individually. It is entirely possible that residential consumers are unaware of the price they are being charged for electricity and hence are not sensitive to price changes. It is also possible that electricity consumption represents so

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55/ LADWP, in a rather late response to an interrogatory, provided the required data for the three customer categories on August 19, 1975; too late a date to be included in the analysis.

56/ It should be noted at this point that an earlier draft of this report dated August 12, 1975, reported that price was not significant in the commercial plus industrial sector (t-value equalled -1.29). Minor inconsistencies in the input data were found, which, when corrected, resulted in price becoming significance. Evidently the significance of this variable is quite sensitive to relatively small variations in the data.

Table 15

Energy Resources Conservation and Development Commission
Estimation Results

Dependent Variable	Time Period	Independent Variables					R^2	F	P		D-W
		Constant	CDY	PR	GSP	PCI			(Ho: P=0)	(Ho: P=1)	
1) RKWH	1960-74	-46,707.2	1115.0 (7.12)**	552.1 (1.56)*			.97	194			.50
1') RKWH	1960-74	-33,352.2	1041.7 (7.36)**	32.6 (0.11)			.99	544	.71 (3.75)**	(1.55)*	1.90
2) CIKWH	1960-74	-26,681.1			1050.9 (19.6)**	-445.5 (-.99)	.99	619			.54
2') CIKWH	1960-74	-28,218.3			1103.9 (15.35)**	-664.6 (-1.95)**	.99	544	.59 (2.77)**	(1.91)*	1.76
3) RKWH	1960-74	-32,405.8	1034.9 (9.87)**				.99	97	.71 (3.82)**	(1.55)*	1.88

* Significant at 10% level with a one-tail test.
** Significant at 5% level with a one-tail test.

small a portion of the typical residential consumer's budget that a change in electricity price would not be expected to cause him to decrease his consumption of electricity in the same way as it would if the expenditure on electricity consumption represented a much larger portion of his budget. Since residential consumers have recently become increasingly aware of the price of electricity and since expenditures on electricity consumption are likely to take a larger portion of the typical residential consumer's budget in the near future, much more careful study of the residential consumer's response to price will need to be conducted before reaching a firm assessment of the role residential price is likely to play.

Since the price variable was insignificant in equation (1'), this equation is re-estimated in equation (3) with the price variable removed; disposable personal income remains a significant variable in both cases.

Conclusions

The results presented in Table 15 indicate that it is possible to develop an explicit methodology using commonly accepted analytic techniques for the purpose of forecasting the demand for electricity. That is, equations (2)' and (3) were estimated using a data base furnished by the utilities and they do represent an explicit methodology. The optimal predictor developed by

Goldberger would provide a forecasting method. 57/

These equations are merely illustrative of the type of improvement possible in the methodology used by the CPUC and should not be considered as an adequate basis for forecasting.

57/ (21). For further discussion refer to (22), pp. 280-281.

CHAPTER III

REVISIONS TO FORECASTING METHODOLOGIES

Introduction

It is apparent from Chapter 2 that the current demand forecasts and the methodologies in use by the utilities and by the Public Utilities Commission are inadequate. Before any power plant siting decision is made, the staff recommends that certain additional information and analysis be requested. This chapter will discuss the additional forecasting information the staff believes should be obtained to adequately establish the need for a site.

Supply Model

Prices and quantities produced and consumed are determined by the interaction of supply and demand; forecasting without consideration of this interaction is clearly inadequate. Therefore, supply models should be constructed and demand models improved in order to estimate future kilowatt-hour sales or peak demands based on simultaneous consideration of demand and supply.

Data

The data presented by the utilities and by the Public Utilities Commission form an inadequate basis for forecasting.

The data for every analytical step should be required by the Commission in any future projection of demand and supply.

More specifically, data should be obtained on individual customer sales by rate schedule category and by characteristics of the individual customer.

San Diego Gas & Electric supplied some data of this type and Southern California Edison evidently possesses similar data. While, as Southern California Edison demonstrated in its price elasticity study, the construction of a demand equation on the basis of this data is possible even more disaggregated data will be necessary in the future. The CPUC staff has recommended that the utility companies study price elasticities -- including cross-elasticities -- for electricity.58/ This will be particularly necessary with respect to an anlysi of alternative rate structures. The Energy Commission needs to know not only the number of customers for each rate class, the total consumption of kilowatt-hours and the total revenue generated on a monthly and yearly basis, but also needs sample information for individual customers within each class.

In addition, the Commission should obtain sample information on such variables as: (1) the number and type of appliances and lighting devices within a residence, the location and size of the residence, the average disposable income of the household, the number of people in the household and their ages, the educational level of the heads of household; (2) the type of industrial firm by product (e.g., whether aluminum products, automotive parts, fabrics, furniture, etc.), the amount and type of electricity consuming capital goods used by the customer, the rate schedule, the total consumption of kilowatt-hours, time of peak loads where metering is available, the total revenue generated by this consumption (on both a monthly and a yearly basis); the monthly and yearly dollar value of the

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58/ (25) p. 7-2

sales of both the firm and the industry, the geographical location of the firm, and the availability, price, and consumption of alternative sources of energy such as natural gas; and (3) approximately the same statistics as in (2) above for commercial customers. Some of this data has evidently been collected. For example, Southern California Edison has cited biennial surveys of appliance saturation conducted by the Electric Energy Association, a subsidiary of the Edison Electric Institute. The individual records from these surveys, for the State of California at least, should be a part of a common data base. The collection of some of the required data, however, will represent a substantial effort in a new and uncharted direction.

The preceding discussion presented data requirements for demand estimation. However, important data needs to be obtained regarding supply. Data is needed for each individual generating plant concerning the amount and type of each fuel used, its cost and availability; the size of the generating plant (both the present scale and expected future additions to plant capacity); the extent to which its capacity is utilized at all times of the year, including daily loading patterns; the type and amount of labor required along with its cost; and the allocated cost (on both an installation and maintenance basis) to that generating plant of installing meters which would measure and appropriately charge individual customers in each rate schedule category according to the amount and time of electricity use. Finally, the Commission required data should include the construction dates, expected life, and total capital cost, including interest rate(s), for each individual generating station plus attendant transmission and distribution networks.

All these data provide only the bare minimum for reasonably accurate estimation of the basic supply relationships in the electric utility industry. These relationships will need to be investigated by the utilities in much more detail than they have been in the past. However, the data itself will be insufficient unless more detailed discussions of the analyses performed on the data to arrive at forecasts is also provided.

Peak-Load Pricing

Future forecasts should also require evidence and analysis concerning the effects of peak-load pricing on: (1) the extent of capacity utilization and of future capacity requirements; (2) the level of present and future kilowatt-hour sales; and (3) energy conservation measures. This data can be made available only if, in the near future, California utilities begin practicing and collecting data on peak-load pricing.

The Public Utilities Commission staff has recommend that the utility industry collect experimental data on peak-load pricing. The industry has argued against such pricing on the basis that it would require massive capital outlays for metering devices. However, the CPUC staff pointed out that for "large usage customers....substantially all the necessary metering equipment already exists." 59/ The CPUC staff went on to recommend that the rate schedules of these large customers include peak-load prices.

59/ (25) p. 404

Conservation

The most appropriate way to gauge the impact of California conservation efforts would be in a full and complete equilibrium model for California. Such a model is to be constructed in the near future. In the absence of a California model, however, it is possible to obtain some insight into the potential results of conservation efforts by examining an equilibrium model developed by the FEA for the entire nation.[60/] The results of the FEA analysis, of course, are not directly applicable to California since 1) the conservation measures used in the FEA analysis may not be the same as those adopted in, by or for California, 2) the equilibrium results of the FEA national model would not apply to any one state even if all the conservation measures adopted were the same as those used in the FEA analysis due to the fact that no one state is just a smaller replica of the nation. Nevertheless, it is useful to mention the results of the FEA analysis in order to stress the potential importance of conservation measures.

The assumptions embodied in the conservation "scenario" used by FEA entailed the following actions:

1. A mandatory 20 m.p.g. efficiency standard for autos.
2. Increased use of public mass transit.
3. Subsidize retrofitting existing homes (25% tax credit).
4. Subsidize energy-reducing commercial investment (15% investment tax credit).
5. Mandatory thermal efficiency standards for new residential and commercial buildings.
6. Mandatory lighting standards for commercial buildings.
7. Mandatory appliance efficiency standards.
8. Increased research and development in efficient industrial processes.
9. Demonstration projects in support of adding energy conservation standards to the Federal Power Act.

60/ (24)

The effects of conservation in the FEA model were determined by examining the full equilibrium results for various other scenarios "with" and "without" the conservation scenario assumptions. The results for the electricity sector indicated that in 1984 there was a 10% reduction in the total number of kilowatt-hours of utility electricity consumed by the nation.

The FEA also examined the results of a so-called demand-management scenario. It should be pointed out, however, that this scenario is not based on the results of the full and complete equilibrium model. Rather, it is an add on calculation.

For this reason, the results of the demand-management scenario are not comparable with the conservation scenario results. Though the demand-management notion is based upon the belief that we could achieve independence in energy by shifting to domestic energy sources like coal that are in relative abundance, the FEA analysis indicates that this approach is more costly to the nation, and does little to achieve independence.

It is clear that the potential impact of various conservation efforts anticipated in the next ten years will need to be investigated with particular emphasis on California and its special problems and requirements. These include changes affecting appliance and lighting efficiencies, home insulation, building design, solar heating, fuel cells, and transmission systems, along with the effects of voluntary conservation programs. Conservation resulting from such policy instruments as revised buildings codes should also be investigated.

Sample Calculations

Each forecast provided by the utilities should be accompanied by a detailed sample calculation indicating how the forecasted kilowatt-hour sales for each customer class was derived from the available raw data presented. The specification of the model should be clear and rigorously defined against reasonable alternative specifications.

Scenario Development

To accurately assess the various forecasts, a number of possible scenarios or "conditional forecasts" and their anticipated effects should be prepared.

Any series of scenarios should include scenarios similar to those in the Federal Energy Administration's Project Independence. Additionally, scenarios might be defined for such items as fuel availabilities, interest, rates, type of power plant (i.e., nuclear, coal, geothermal, etc.) air quality standards, energy conservation strategies, and alternative rate policies.

Statistical Rigor

It will be necessary to obtain some indication of the confidence associated with projected values in the forecasts. That is, not only should there be a set of projected values but also a range of possible projected values together with an indication of how likely the various values in this range may be. This will require specifications of the possible scenarios and their expected or anticipated effects. The forecasts should be tested to ascertain their sensitivity to changes in assumptions or errors in estimation or specification.

Technical Conclusions

The staff finds the PUC methodology to be inadequate for the Energy Commission's purposes.

In view of this finding and in accordance with the analysis presented to the Energy Commission by the representative of the Attorney General's Office at the August 6, 1975 Energy Commission meeting, the staff recommends the following steps to assure timely adoption of the Energy Commission forecasts of future loads and resources:

1. The staff should prepare forecasts of future loads and resources for Commission consideration at such times as the availability of important new data, significant external events or institutional changes, or improvements in methodology warrant.

2. The staff notes that the timely production of these forecasts is partially dependent upon receipt of reasonably complete data from the electric utilities and other sources. These data have been sought through formal requests and interrogatories from each utility, but have not been received in satisfactory form. The Commission should consider further measures to ensure receipt of these data.

3. The staff will continue its own efforts to independently obtain the necessary data and will clearly identify assumptions used in its own forecasting efforts.

4. The staff will endeavor to produce its forecasts in sufficient time for meaningful Commission deliberations prior to the deadlines for decisions on Notices of Intent.

APPENDIX

TABLE A-1
THREE UTILITIES HISTORICAL DATA FOR COMMERCIAL-INDUSTRIAL SALES, 1960-1974

(Millions of Kilowatt-Hours)

YEAR	PG & E[1]	SCE[2]	SDG & E[3]	TOTAL
1960	11,300	10,418	1,488	23,206
1961	12,100	11,229	1,660	24,989
1962	12,962	12,276	1,752	26,990
1963	13,990	13,649	1,868	29,507
1964	15,361	15,065	2,004	32,430
1965	16,640	16,479	2,177	35,296
1966	18,364	18,516	2,480	39,360
1967	19,639	20,042	2,712	42,393
1968	21,255	21,702	2,997	45,954
1969	22,717	23,333	3,347	49,397
1970	23,740	25,080	3,683	52,503
1971	24,798	26,246	4,043	55,087
1972	26,550	27,787	4,413	58,750
1973	28,094	28,947	4,719	61,760
1974	26,852	27,068	4,545	58,465

[1] The 1961-1974 data is from Pacific Gas and Electric written submission, Appendix A. The 1960 figure was extrapolated from later years {11,300=12,100/1.0708}.

[2] Southern California Edison written submission, p. 50.

[3] The 1960-1972 data is from San Diego Gas & Electric Company written submission, Appendix C of Exhibit 3. The 1973 and 1974 data is from response to Interrogatory Number 23.

TABLE A-2
THREE UTILITIES HISTORICAL DATA FOR RESIDENTIAL SALES, 1960-1974

(Millions of Kilowatt-hours)

YEAR	PG & E[1]	SCE[2]	SDG & E[3]	TOTAL
1960	5,650	3,988	878	10,516
1961	6,206	4,385	940	11,531
1962	6,708	4,943	1,026	12,677
1963	7,336	5,473	1,089	13,898
1964	8,012	6,350	1,190	15,552
1965	8,696	7,144	1,282	17,122
1966	9,384	7,915	1,388	18,687
1967	10,310	8,775	1,543	20,628
1968	10,913	9,355	1,706	21,974
1969	11,946	10,457	1,933	24,336
1970	12,576	11,154	2,113	25,843
1971	13,700	12,283	2,429	28,412
1972	14,575	12,934	2,661	30,170
1973	15,558	13,532	2,880	31,970
1974	15,658	13,060	2,913	31,631

[1] Pacific Gas and Electric data for 1961-1974 is from Appendix A of written submission. The data for 1960 is from Tables 23-2 and 23-5 of interrogatory response. The sales figures in the two tables were multiplied by 1.024 to adjust to a comparable basis with the 1961-1974 data.

[2] Southern California Edison written submission, p. 50.

[3] San Diego Gas and Electric written submission, Appendix C and Interrogatory response, Number 23.

TABLE A-3
Gross State Product (GSP) and California Disposable Income (CDY), 1960 - 1974

(Billions of 1958 Dollars)

YEAR	GSP	CDY
1960	51.5	36.5
1961	53.8	38.4
1962	57.4	40.5
1963	60.7	42.8
1964	63.7	45.8
1965	65.7	47.6
1966	70.4	50.1
1967	72.6	52.0
1968	76.6	54.3
1969	78.7	54.8
1970	78.8	56.0
1971	80.6	57.9
1972	85.5	59.7
1973	88.1	61.6
1974	86.8	60.9

SOURCE of GSP & CDY: Southern California Edison written submission, Systems Forecast, 1975-1994, Table IV-B,p.28.

TABLE A-4

WEIGHTED AVERAGE PRICE FOR COMMERCIAL-INDUSTRIAL SECTOR, 1960-1975

Year	PG&E[1]				SCE[2]				SDG&E[3]						TOTAL[4]	
	Commercial Demand		Commercial Non-Demand		Commercial		Industrial		Commercial		Gen. Power		Agricultural			
	Sales*	Aver. Price*	Sales	Aver. Price	Sales	Aver. Price	Sales	Aver. Price	Sales	Aver. Price	Sales	Aver. Price	Sales	Aver. Price	Sales	Aver. Price
1960	9,842	12.5	2,174	32.3	3,430	22.0	6,988	11.0	1,302	17.9	186	20.0			23,922	15.6
61	10,539	12.5	2,328	32.3	3,822	21.4	7,407	10.9	1,470	17.6	191	19.9			25,757	15.5
62	11,273	12.5	2,431	32.3	4,205	21.2	8,071	10.9	1,557	17.7	195	19.9			27,732	15.5
63	12,134	12.6	2,547	32.1	4,734	21.1	8,915	10.7	1,661	17.6	206	19.5			30,197	15.3
64	13,135	12.4	2,689	31.2	5,361	19.6	9,704	10.3	1,796	17.5	209	19.4			32,894	14.8
65	9,654	13.4	2,928	30.4	5,940	18.7	10,539	10.0	1,992	17.1	184	19.2			31,237	15.1
66	7,269	15.0	3,149	30.2	6,763	18.1	11,753	9.9	2,576	16.8			95	18.5	31,415	15.4
67	7,694	15.0	3,253	29.8	7,551	17.7	12,491	9.9	2,803	16.5			91	18.8	33,701	15.3
68	8,423	14.9	3,315	29.6	8,269	17.3	13,433	9.8	3,103	16.2			106	18.0	36,437	15.0
69	9,089	14.8	3,489	29.5	9,208	17.2	14,125	9.8	3,441	16.0			94	18.5	39,253	15.0
70	9,587	14.8	3,590	29.5	10,118	17.8	14,962	10.0	3,797	16.0			114	17.5	41,940	15.2
71	10,107	15.5	3,910	31.0	11,005	18.4	15,241	10.5	4,155	16.0			112	17.6	44,306	15.9
72	10,899	15.6	4,285	31.1	12,044	19.7	15,743	11.7	4,536	17.1			123	18.3	47,384	16.9
73	11,658	16.6	4,446	32.1	12,524	22.1	16,923	14.0	4,837	18.7			118	20.9	49,770	18.7
74	11,276	20.2	4,250	35.8	11,515	31.7	15,553	22.8	4,670	28.2			125	28.2	47,139	25.9

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* The sales are in millions of kilowatt-hours; average price is mills per kilowatt-hour.

1/ The 1961-1974 data is from Pacific Gas and Electric Answers to Interrogatories, Tables 23-8, 9, 11, 12. The 1960 figures were extropolàted assuming: (1) constant money price of electricity; and (2) that the 1960 sales data was proportional to 1961 data. Industrial sales are not included, because that data was not supplied by Pacific Gas and Electric Company.

2/ Southern California Edison Interrogatory response, Tables 9 and 11.

3/ The data is from San Diego Gas and Electric Interrogatory response number 23.

4/ The San Diego Gas and Electric Agricultural class was subtracted from the total of all other classes for the years 1966-1974 to arrive at data listed in TOTAL columns.

TABLE A-5

WEIGHTED AVERAGE PRICE FOR RESIDENTIAL SALES, 1960 - 1974

CURRENT DOLLARS

Year	PG&E[1]				SCE[2]		SDG&E[3]		TOTAL	
	Individual Meter		Master Meter							
	Sales*	Average Price*	Sales	Average Price	Sales	Average Price	Sales	Average Price	Sales	Weighted Average Price
1960	5,460	25.9	59	23.8	3,988	29.4	878	27.4	10,385	27.4
1961	5,999	25.4	62	23.3	4,385	28.8	940	27.0	11,386	26.9
1962	6,486	24.9	65	22.9	4,943	27.9	1,026	26.5	12,520	26.2
1963	7,095	24.2	71	22.4	5,473	27.3	1,089	25.9	13,728	25.6
1964	7,750	23.3	101	24.1	6,350	25.7	1,190	24.6	15,391	24.4
1965	8,410	22.6	134	24.6	7,144	24.6	1,282	23.9	16,970	23.5
1966	9,079	22.2	141	24.3	7,915	23.9	1,388	23.5	18,523	23.0
1967	10,069	21.6	151	23.8	8,775	23.2	1,543	22.8	20,538	22.4
1968	10,754	21.3	159	23.6	9,355	22.9	1,706	22.3	21,974	22.1
1969	11,779	20.8	169	23.3	10,457	22.7	1,933	21.7	24,336	21.7
1970	12,406	20.6	169	23.3	11,154	24.3	2,113	23.4	25,843	22.3
1971	13,514	21.7	186	24.2	12,283	24.8	2,429	20.9	28,412	23.0
1972	14,382	22.9	193	24.5	12,934	27.1	2,661	22.2	30,170	24.2
1973	15,354	22.8	204	25.2	13,532	29.2	2,880	24.4	31,970	25.8
1974	15,458	26.2	200	28.6	13,060	38.8	2,913	32.1	31,631	32.0

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* The sales are in millions of kilowatt-hours; average price is mills per kilowatt-hour, in current dollars.

1/ Pacific Gas and Electric, answers to Interrogatories, Tables 23 - 2,3,5,6.

2/ Southern California Edison, answers to Interrogatories, Tables 9 and 11.

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APPENDIX I-3

Federal and State Ownership Distribution Within Coal Lease Area

APPENDIX 1- 3

FIGURE 1

FEDERAL AND STATE OWNERSHIP DISTRIBUTION WITHIN COAL LEASE AREA

KAIPAROWITS PROJECT

(Resources Company, Mono Power Company, New Albion Resources Company)

Federal			State		
Map Designation	Lease Number	Acreage	Map Designation	Lease Number	Acreage
A	U-087805	2,064.44	a	19427	640.00
B	U-087806	1,945.32	b	19432	640.00
C	U-087807	1,920.00	c	19650	640.00
D	U-087828	2,560.00	d	19651	640.00
E	U-087833	2,517.68	e	19653	690.44
F	U-087834	2,560.00	f	19654	640.00
G	U-087835	1,920.00	g	19655	400.00
H	U-087836	640.00	h	19656	640.00
I	U-092138	1,891.44	i	19678	640.00
J	U-092139	1,934.73	j	19679	640.00
K	U-092140	2,022.48	k	19680	640.00
L	U-092141	1,972.16	l	19786	640.00
M	U-092142	1,750.20	Total		7,490.44
N	U-096486	640.00			
O	U-096494	2,560.00			
P	U-096495	2,559.84			
Q	U-096496	2,560.00			
R	U-096497	2,560.00			
S	U-096508	658.28			
T	U-096509	1,478.70			
U	U-0101142	1,562.80			
Total		40,277.35			

Federal	40,277.35
State	7,490.44
TOTAL	47,767.79

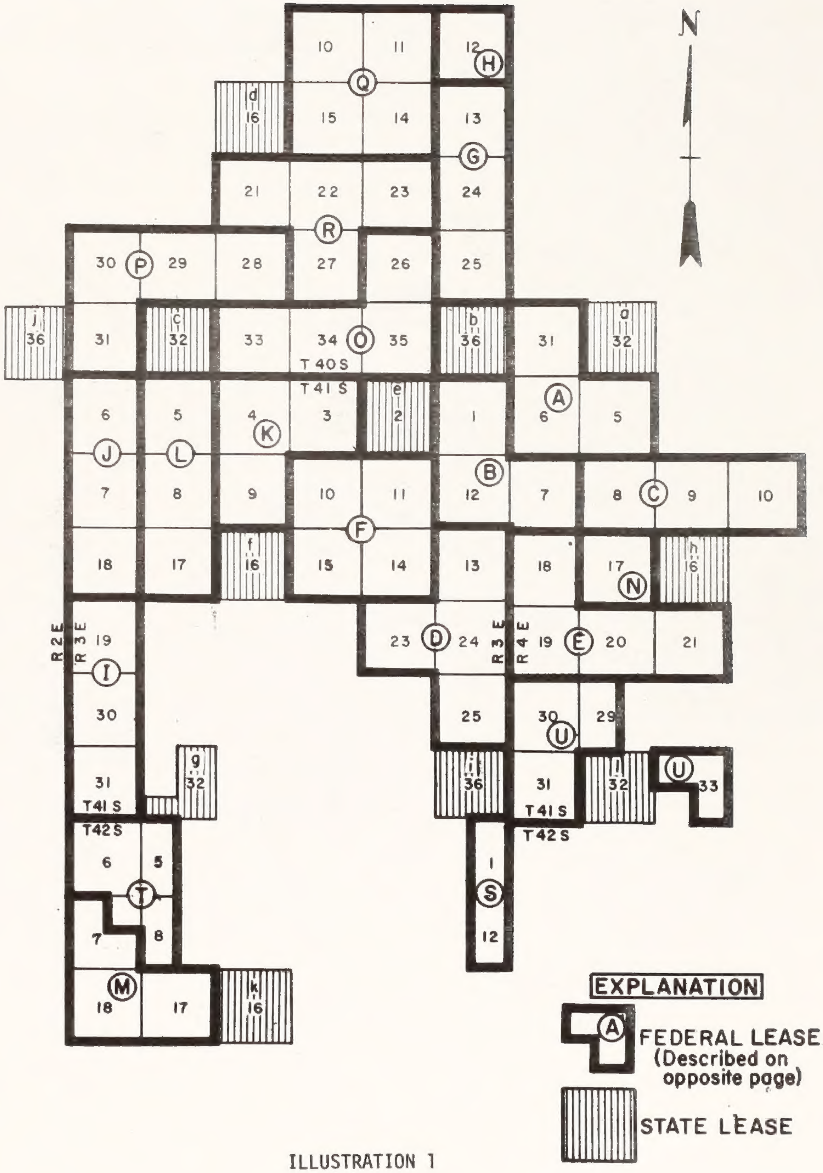

ILLUSTRATION 1

Federal and State Ownership Distribution Within Coal Lease Area

APPENDIX I-4

Typical Coal Lease Contract

APPENDIX I- 4

Form 4-696
(January 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

COAL LEASE

Land Office
Salt Lake City, Utah

Serial Number
Utah 087806

This lease, entered into on the 1st day of November, 1965, by the United States of America, the lessor, through the Bureau of Land Management, and

Resources Company
P. O. Box 1432
Phoenix, Arizona

Associated Southern Investment Company
100 Long Beach Boulevard
Long Beach, California

New Albion Resources Co.
P. O. Box 168
San Diego, California

, the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force which are made a part hereof,

WITNESSETH:

Sec. 1. *Rights of Lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of Utah:

Salt Lake Meridian, Utah

T. 41 S., R. 3 E.,
sec. 1 and 12.

T. 41 S., R. 4 E.,
sec. 7.

GEOLOGICAL SURVEY
SALT LAKE CITY, UTAH
MINING BRANCH

containing 1,945.00 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

b) Rental. To pay the lessor annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year; 50 cents for the second, third, fourth, and fifth years, respectively; and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

See Sec. 2(c) on last page of lease.

(c) Royalty. ~~To pay the lessor a royalty of cents on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.~~

(d) Minimum production. Beginning with the sixth year of the lease, *except* when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate *except* at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous *except* in circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

(e) Payments. To make rental payments to the Manager of the appropriate Land Office, *except* that when this lease becomes productive the rentals and

royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the appropriate regulations.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Nondiscrimination clauses. During the performance of this contract the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this lease may be cancelled, terminated, or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

(k) Land disposed of with coal deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) Operations, wages, freedom of purchase. To comply with the appropriate operating regulations, to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground

workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman, without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms. The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, *except* the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, *except* underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22), and Sections 431, 432, and 433, Title 18, U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

Sec. 2 (c). Royalty. To pay the lessor a royalty of 15 cents on every ton of 2,000 pounds of coal mined by underground methods and 17½ cents on every ton of 2,000 pounds of coal mined by surface methods, including auger mining, for the first 10 years, and 17½ cents on every ton of 2,000 pounds of coal mined by underground methods and 20 cents on every ton of 2,000 pounds of coal mined by surface methods, including auger mining, for the second 10-year period. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

Sec. 10. Mining or exploratory operations shall not be conducted which, in the opinion of the Regional Mining Supervisor, Geological Survey, would be hazardous to oil and gas production ** or would unreasonably interfere with the orderly development and production under oil and gas leases issued for the same lands prior to the date of the permit going to preferential right lease.

THE UNITED STATES OF AMERICA

By ______________________

(Signing Officer)

Ed. D. Cox

Acting Chief, Minerals Section

(Title)

OCT 29 1965

(Date)

WITNESS TO SIGNATURE OF LESSEE

____

____

____

RESOURCES COMPANY,
ASSOCIATED SOUTHERN INVESTMENT COMPANY
NEW ALBION RESOURCES COMPANY

(Signature of Lessee)

By ______________________

(Signature of Lessee)

Howard L. Edwards
141 ~~East~~ First South
Salt Lake City, Utah
Agent and Attorney-in-Fact

(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

APPENDIX I- 5

Agreement Between the Central Utah Water Conservancy District and Resources Company, Associated Southern Investment Company and New Albion Resources Company dated May 19, 1965

APPENDIX I-5

AGREEMENT

THE CENTRAL UTAH WATER CONSERVANCY DISTRICT, a body politic of the State of Utah, herein called "District," and RESOURCES COMPANY, a corporation, ASSOCIATED SOUTHERN INVESTMENT COMPANY, a corporation, and NEW ALBION RESOURCES COMPANY, a corporation, herein called "Companies," have this 19th day of May, 1965, agreed as follows:

I.

DEFINITIONS

As used in this agreement:

(a) "The Central Utah Water Conservancy District" means a body politic of that name organized by decree of the Fourth Judicial District Court, State of Utah, dated March 2, 1964, under the authority of Chapter 9, Title 73, Utah Code annotated, 1953, as amended.

(b) "Central Utah Project" means the project of the United States, Bureau of Reclamation, consisting of the Vernal, Bonneville, Upalco, Jensen and Uintah Units and the Ultimate Phase.

(c) "Initial Phase" means that part of the Central Utah Project authorized by the Colorado River Storage Project Act, 43 U.S.C. 620, including the Vernal Unit, which is complete, the Bonneville Unit, which is described in Bureau Definite Plan Report dated August, 1964, and the Jensen, Upalco and Uintah Units as set out in the "Applications of the District for the Initial Phase" which phase is hereinafter defined.

(d) "Ultimate Phase" means that part of the Central Utah Project that has not yet been authorized by Congress, but does not include the Uintah Unit, which for the purpose of this agreement is deemed to be one of the features of the Initial Phase.

(e) "Kaiparowits Power Project" means the project proposed by the Companies to generate electricity at a coal-fired electric generating plant on the Kaiparowits Plateau in Kane County, Utah.

(f) "Companies" means Resources Company, a corporation organized under the laws of the State of Arizona and qualified to do business in the State of Utah, which is a wholly owned subsidiary of Arizona Public Service Company of Phoenix, Arizona; Associated Southern Investment Company, a corporation organized under the laws of the State of California and qualified to do business in the State of Utah, which is a wholly owned subsidiary of Southern California Edison Company of Los Angeles, California; and New Albion Resources Company, a corporation organized under the laws of the State of California and qualified to do business in the State of Utah, which is a wholly owned subsidiary of San Diego Gas & Electric Company of San Diego, California.

(g) "Bureau" means the Bureau of Reclamation, United States Department of the Interior.

(h) "Engineer" means the Utah State Engineer or that agency of the State of Utah charged with the adjudication of the appropriation of the public waters of the State of Utah.

(j) "Acre foot" means the quantity of water required to cover an acre to a depth of one foot and is equivalent to 43,560 cubic feet.

(j) "Application No. 35818" means Application to Appropriate Water No. 35818, as amended, in the name of the Companies, filed with the Engineer.

(k) "Applications of the District for the Initial Phase" as used herein means the applications to appropriate water in the name of the United States Bureau of Reclamation filed with the Engineer for the

Vernal, Bonneville, Upalco, Jensen and Uintah Units of the Initial Phcase of the Central Utah Project, being Applications Nos. 18043 (filed in part to provide water for the Bonneville Unit), 36638 (filed for Starvation Reservor, which is part of the Bonneville Unit), 36639 which was filed as a possible substitute for 18043 and 36638, 36642 (Upalco Unit), 36644 and 30416 (Uintah Unit), 17558 and 30415 (Jensen Unit), and applications for the Vernal Unit which is already fully constructed.

II

PRELIMINARY RECITALS

A. The District is charged with cooperation with the United States and agencies thereof to contract for and repay the costs of the authorized and presently planned units of the Central Utah Project, and

B. The Companies are the applicants under Application No. 35818 and propose the diversion and use of up to 102,000 acre feet of water each year from the Colorado River in connection with the Kaiparowits Power Project, as stated in that application, and

C. The parties to this agreement recognize that there exists during or as a result of low water years the possibility of conflict between the demands for water from the Colorado River for use in connection with the Kaiparowits Power Project, and

D. The parties are desirous of agreeing on principles and a plan respecting, as between the parties, the priorities for use of the Colorado River waters in the event of such conflict in order that both projects may be developed and that protests and litigation may be avoided and the parties are willing to enter the agreements and covenants stated herein.

III

AGREEMENT OF THE PARTIES

A. Priority of Initial Phase:

The right of the District to use Colorado River water from the particular rivers and tributaries described as points of diversion in the Applications of the District for the Initial Phase of the Central Utah Project, including the Uintah Unit, shall have priority over the right of the Companies to use Colorado River water for the Kaiparowits Power Project pursuant to Application No. 35818, provided, however, that the priority rights of the District granted by this paragraph for the Initial Phase under its Applications Nos. 18043, 36638, 36639, 36642, 36644 and 30416, combined, shall not exceed a total of 700,000 acre feet of diversions in any calendar year.

B. The Period of Years Through 2010, A.D.:

Through the year 2010, A.D., the use of water for the Kaiparowits Power Project shall have priority over the use of water for the Ultimate Phase of the Central Utah Project (except the Uintah Unit which for the purpose of this agreement is considered a part of the Initial Phase).

The District agrees that it will not proceed under the Ultimate Phase of the Central Utah Project to divert water to the extent that such diversions would prevent the Companies' use of 102,000 acre feet per annum through the year 2010, A.D. It is understood that the District does not guarantee that amount of water to the Companies against diversions by others and does not agree to curtail any diversions which the District would be authorized to make under Paragraph A above for the Initial Phase of the Central Utah Project, including the Uintah Unit.

C. The Period of Years After 2010, A.D., Through 2030, A.D.:

(i) The years after 2010, A.D., through 2020, A.D.:

During the period after the year 2010, A.D., through the year 2020, A.D., the right to use 82,000 acre feet of Colorado River water each year for the Kaiparowits Power Project shall have priority over the use of Colorado River water for the Ultimate Phase of the Central Utah Project. The right to use an additional 20,000 acre feet of Colorado River water each year during that period for the Kaiparowits Power Project shall be subordinate and junior in priority to the use of water by the Ultimate Phase of the Central Utah Project.

(ii) The years after 2020, A.D. through 2030, A.D.:

During the period after the year 2020, A.D., through the year 2030, A.D., the right to use 62,000 acre feet of Colorado River water each year for the Kaiparowits Power Project shall have priority over the use of Colorado River water for the Ultimate Phase of the Central Utah Project. The right to use an additional 40,000 acre feet of Colorado River water each year during that period for the Kaiparowits Power Project shall be subordinate and junior in priority to the use of water by the Ultimate Phase of the Central Utah Project.

D. The Period of Years After 2030, A.D.:

After the year 2030, A.D., the right to use Colorado River water for the Ultimate Phase of the Central Utah Project shall have priority over the right to use Colorado River water for the Kaiparowits Power Project.

E. Reversion to State of Utah:

The Companies agree that upon abandonment of the Kaiparowits Power Project their rights to use water pursuant to Application No. 35818 shall revert to the State of Utah. The Companies further agree that should the Companies elect not to submit proof of completion of works and application of the quantity of water covered by Application 35818 to beneficial use, then that quantity of water for which works are not completed or which is not put to beneficial use will, as provided in the Utah Water Appropriation Statute (Chapter 3, Title 73, Utah Code Annotated, 1953, as amended) revert to the State of Utah.

IV

LOCATION OF KAIPROWITS POWER PROJECT

The Companies agree not to transfer or otherwise use the water for purposes other than the Kaiparowits Power Project and agree that the Kaiparowits Power Project, if constructed, will be constructed in the State of Utah. The Companies further agree that they will encourage construction in the State of Utah of development related to the Kaiparowits Power Project.

V

USE OF AGREEMENT BY THE ENGINEER

The parties agree that the provisions of this agreement may be incorporated as conditions in any decisions of the Engineer on any applications to appropriate water filed by the parties to this agreement with the Engineer seeking to appropriate water from the Colorado River or its tributaries.

VI

ASSIGNMENT

The Companies may at any time assign this agreement and all rights and priviledges of the companies under this agreement shall inure to the benefit of their successors and assigns.

IN WITNESS WHEREOF, the parties have set their hand and seal the day and year first above written.

THE CENTRAL UTAH WATER
CONSERVANCY DISTRICT

By
Sterling D. Jones, Chairman

ATTEST:

Secretary

RESOURCES COMPANY

By
Its VICE PRESIDENT

ATTEST:

Secretary

ASSOCIATED SOUTHERN INVESTMENT
COMPANY

By
Its President

ATTEST:
Edith
Asst Secretary

NEW ALBION RESOURCES COMPANY

By
Its VICE PRESIDENT

ATTEST:

Secretary

APPENDIX I-6

Indian Deferral Agreement Dated September 20, 1965
(Contract No. 14-06-W-194)

Conformed Copy

Contract No. 14-06-W-194

AGREEMENT

THIS AGREEMENT made and entered into this 20th day of September, 1965, pursuant to the Act of June 17, 1902, and acts amendatory thereof and supplementary thereto, and particularly the Act of April 11, 1956 (70 Stat. 105), by and between the United States of America acting through the Bureau of Reclamation and Bureau of Indian Affairs, Department of Interior, the Ute Indian Tribe of the Uintah and Ouray Indian Reservation, organized pursuant to the provisions of the Indian Reorganization Act of June 18, 1934 (48 Stat. 984) as amended, and the Central Utah Water Conservancy District, a public corporation.

WITNESSETH:

WHEREAS, the Central Utah project is planned for development and construction in two phases, initial and ultimate, and

WHEREAS, the project includes three major units, Bonneville, Upalco and Uintah, all or a part of which involve the Uintah and Ouray Indian Reservation within the Uintah Basin, two of which, Bonneville and Upalco, are included in the initial phase and the Uintah in the ultimate phase, and

WHEREAS, there are approximately 36,450 acres of land served or to be served from the Duchesne River, Bonneville Unit; 33,450 acres of land served or to be served from the Lakefork River, Upalco Unit; and 39,648 acres of land served or to be served from the Uintah River, Uintah Unit, either owned by Indians or non-Indians, but all of which are supplied or are to be supplied with water through original Indian water rights, and

WHEREAS, the Indian water right land has been scheduled in five separate groups for identification purposes, described as group (1) for which a Federal Decree has been entered, 25,070 acres of which are served or to be served from the Lakefork River and 34,152 acres from the Uintah River; group (2) consisting of 18,613 acres designated by the Secretary of the Interior as a part of the Uintah Indian Irrigation Project, and for which a certificate has been issued by the State Engineer of Utah and served from the Duchesne River; group (3) consisting of 1,115 acres designated by the Secretary of the Interior as a part of the Uintah Indian Irrigation Project and served or to be served from the Duchesne River but for which no certificate has been issued by the State Engineer of the State of Utah; group (4) consisting of 1,400 acres of original Indian allotted land served or to served from the Duchesne River; and group (5) consisting of 29,118 acres of practicably irrigable land presently not under irrigation, 15,242 acres of which are to be served from the Duchesne River, 8,380 acres to be served from the Lakefork River and 5,496 acres to be served from the Uintah River, and

WHEREAS, development of all of group (5) land is proposed to be deferred to the ultimate phase of the Central Utah project, and

WHEREAS, the United States, acting through the Bureau of Reclamation, intends to construct the Bonneville unit of the Central Utah project as a part of the initial phase, and

WHEREAS, there are approximately 36,450 acres of land on the Duchesne River, either owned by Indians or non-Indians, but all of which are supplied or are to be supplied with water through original Indian water rights, and

WHEREAS, part of the Bonneville unit water supply will be used to irrigate approximately 10,000 acres of Indian water right lands under the existing Duchesne Feeder Canal and Midview Reservoir in order to free Lakefork River water for use upstream on lands in the Moon Lake Project, and

WHEREAS, the Ute Indian Reservation was established on the 3rd day of October 1861, embracing all of the three Unit Areas as described in the third whereas clause hereof, with the reservation of then perfected water rights sufficient to satisfy the future as well as the present need of the Indian Reservation with enough water to irrigate all the practicably irrigable acreage of the Reservation, and

WHEREAS, approximately 15,242 acres of practicably irrigable land within the Uintah and Ouray Indian Reservation of said group (5) lands and within said Bonneville Unit Area are presently not under irrigation, and

WHEREAS, the Ute Indian Tribe of the Uintah and Ouray Indian Reservation, for the considerations and subject to the conditions hereinafter stated, is agreeable to defer the use of water on said 15,242 acres of land for development under the ultimate phase of the Central Utah project;

NOW, THEREFORE, in consideration of the mutual and dependent covenants and conditions herein contained, it is agreed by the parties hereto as follows:

1. That construction of the Bonneville unit of the Central Utah project, initial phase, as authorized by the Congress of the United States, and as planned by the Bureau of Reclamation, may proceed without objection, interference or claim adverse to the water requirements for such unit, as set out in the Duchesne River Area Study Committee, Duchesne River Land and Water Resource Review dated April 1962.

2. That use of water on 21,208 acres of Indian water right land in the Uintah Basin portion of the Bonneville unit, with the priority date of October 3, 1861, described as groups (2), (3), and (4) in said report dated April 1962, is recognized and confirmed.

3. That use of water for the 15,242 acres of Indian owned land, described as group (5) in said Study Committee Report dated April 1962, may be deferred at this time upon the condition that said lands be included in the ultimate phase of the Central Utah project, as hereinafter provided.

4. That deferment of the development of said group (5) lands for irrigation purposes is granted by said Ute Indian Tribe conditioned upon the full and complete recognition of the water rights of said tribe, with a priority date of 1861 in groups (1), (2), (3), (4) and (5) as described in the book of claims filed with the State Engineer, State of Utah, by the Ute Indian Tribe, without resort to litigation.

5. It is further understood and agreed that said deferment

shall neither constitute an abandonment by said tribe, nor be construed as consent to any further deferment of the right to the use of water for the 15,242 acres referred to in paragraph 3 above. If the ultimate phase of the Central Utah project is not completed sufficiently to supply said Indian water rights by the 1st day of January, 2005, equitable adjustment will be made in accordance with said reserved and perfected water rights of the tribe to permit the immediate Indian use of the water so reserved. It is agreed that the first day of January, 2005, shall be mutually considered as the maximum date of deferment and that all phases of the Central Utah project will in good faith be diligently pursued to satisfy all Indian water rights at the earliest possible date. Under no circumstances shall the fixing of such maximum deferment date be construed as an agreement or license to interpose the satisfaction of inferior water rights delaying the satisfaction of said deferred Indian rights, except where the orderly development and construction of the Central Utah project directly requires such deferment of said Indian rights to be supplied from the ultimate phase of said Central Utah project.

6. No Indian water rights, referred to herein, shall restrict the owner thereof to agricultural uses but such rights may be used for purposes other than agricultural, including but not limited to industrial, municipal and recreational uses.

7. That the use of water from the Duchesne River and its tributaries in the Bonneville unit area, unless otherwise agreed in writing, shall be subject (1) to a river headgate diversion allowance of 4 acre-feet per acre annually and (2) shall be delivered generally in accordance with an ideal demand curve for irrigation purposes, except for the purposes described in paragraph 6 hereof.

8. That the point of diversion from the Duchesne River of the Wissiup, Leland and Ouray School canals be moved upstream by the Uintah Indian Irrigation Project to the point-of diversion of the Duchesne Feeder Canal.

9. That facilities will be provided under the Colorado River Storage Act to mitigate for losses to fish, wildlife and recreation upon the lands of the Ute Indian Tribe of the Uintah and Ouray Reservation or of its members caused by the construction and/or operation of the Central Utah project. This provision shall not be construed as any limitation upon the acceptance or use of any benefits as may become available under enhancement provisions of said act.

10. That development of the Uintah Unit of the ultimate phase of the Central Utah project to provide storage of the runoff waters of the Uintah River and its tributaries, be programmed for early authorization and construction.

11. That Bottle Hollow Reservoir be investigated at an early date with a view of including the same as a storage facility of the Uintah Unit.

12. That the exchange of Duchesne River water under the existing Duchesne Feeder Canal and Midview Reservoir for Lakefork River water in order to free Lakefork River water for use upstream on lands in the Moon Lake Project shall not impair the 1861 priority of the

Ute Indian Tribe or its members either in flow or storage right, and such exchange shall not be construed as an exchange of water rights.

13. Nothing herein contained shall be construed as preventing the construction and use of facilities by the Ute Indian Tribe, the Uintah Indian Irrigation Project, or the United States for storage and use of water upon all Uintah Indian Irrigation Project lands not supplied from facilities constructed under the Central Utah project.

14. This agreement is subject to the approval of the Secretary of the Interior or his duly authorized representative.

UNITED STATES OF AMERICA

BUREAU OF RECLAMATION

By /s/ N. B. Bennett, Jr.
Acting Commissioner

BUREAU OF INDIAN AFFAIRS

By /s/ John O. Crow
Deputy Commissioner

UTE INDIAN TRIBE OF THE UINTAH &
OURAY RESERVATION

By /s/ Francis Wyasket
Chairman

CENTRAL UTAH WATER CONSERVANCY DISTRICT

By /s/ Sterling D. Jones
President

APPENDIX I-7

Memorandum Decision by the Utah State Engineer
Approving Water Right Application No. 35818 of
Resources Company, dated September 3, 1965

APPENDIX I-7

BEFORE THE STATE ENGINEER OF THE STATE OF UTAH

IN THE MATTER OF APPLICATION)
) MEMORANDUM DECISION
NO. 35818)

9/3/65

Application No. 35818 was filed by Resources Company, P. O. Box 2591, Phoenix, Arizona. When originally filed on January 15, 1964, it sought to appropriate 200,000 acre-feet of water at alternate points from Lake Powell on the Colorado River for consumptive use in a coal-fed steam-electric power generating plant having a maximum installed generating capacity of five million kilowatts (5,000,000 KW). Thirteen thousand five hundred second-feet of water was also to be diverted continuously and used for cooling purposes.

Notice of this requested appropriation was published in the Southern Utah News, Kanab, Utah, April 16, 23 and 30, 1964, and the Deseret News, Salt Lake City, Utah, April 6, 13 and 20, 1964. Formal protests were filed by the Bureau of Reclamation. A hearing regarding these protests was held at Salt Lake City, Utah, December 14, 1964. The location of the hearing was approved by the applicant.

Prior to this hearing an undivided one-third (1/3)interest in the filing was assigned to each of the following corporations: (1) Associated Southern Investment Company, 100 Long Beach Blvd., Long Beach, California, and (2) New Albion Resources Company, P. O. Box 168, San Diego, California, leaving 1/3 interest in the original applicant. The application has also been amended so that it now provides for the appropriation of 102,000 acre-feet of water from Lake Powell at a point 300 feet east of the SW Cor. Sec. 3, T43S, R4E, SLB&M, to be used for steam-electric power generation. No additional water is to be diverted strictly for cooling purposes as these requirements are included in the 102,000 acre-feet. Also, there is now no proposal to return water to the Lake.

At the hearing on December 14, 1964, representatives of the Utah State Department of Fish and Game withdrew that agency's protest upon the condition that certain requirements be met. These were outlined in a letter from the Department to Mr. M. C. Titus, Vice-President and General Manager of Resources Company dated November 20, 1964, as follows:

"1. That reasonable precautions are taken to exclude game fish from entering the water intake facilities;

"2. That disposition of the ash and fly ash be handled so these materials should not enter the lake."

Acceptance of these conditions was given in a letter by the applicants to the Fish and Game Department dated December 12, 1964, and was also expressed by two of the applicants' witnesses at the hearing.

The objections of the U. S. Bureau of Reclamation may be summarized from the formal written protest as follows:

"1. Lake Powell is formed by Glen Canyon Dam, constructed by the protestant as part of the Colorado River Storage Project pursuant to the Act of Congress dated April 11, 1956, (70 Stat. 105) at a cost of many millions of dollars. Any use of these facilities, including rights of access, or of the water stored therein will require an agreement with the United States.

"2. Because of the large quantity of water for consumptive use described in the application, approval of this application would have an adverse effect thereof on the ultimate Central Utah Project, the Juniper Project, and other projects now being considered by the Bureau of Reclamation, Department of the Interior which are of interest to the State of Utah, and the public at large."

At the hearing the applicants submitted considerable information concerning the availability of raw materials, proposed location of facilities, quantity of water required for various uses, availability of water considering other potential uses in Utah, estimated future power requirements of the service areas, and economic impact of such a project on the State. Interested parties were allowed until February 15, 1965, to submit written statements favoring or objecting to the project. The time was later extended to May 24, 1965. During this extended period, formal protests were received from the following organizations:

(1) Millard County Water Conservancy District
(2) Price River Water Improvement District
(3) Carbon Water Conservancy District
(4) Sanpete Water Conservancy District
(5) Board of County Commissioners of Sanpete County

Several letters and statements in support of this proposal have also been received. All of these protests and statements in support of Application No. 35818 have been given careful consideration.

From all of the above data it is our opinion that the proposal has engineering and financial feasibility and that approval of Application No. 35818 would be in the public interest provided certain requirements are met. We are particularly concerned about the possible future conflict between this power plant and the water needs for the Ultimate Phases of the Central Utah Project and other presented proposed but not authorized projects.

Recognizing this potential conflict and the possibility for scheduling of construction of the various projects, the applicant companies and the Central Utah Water Conservancy District have held several meetings in an attempt to arrive at a basis for agreement regarding this matter. On May 24, 1965, we received a copy of an agreement dated May 19, 1965, between the Central Utah Water Conservancy District and the applicant companies in which they appear to have resolved any differences. A copy of said agreement is attached to this Memorandum Decision as Appendix "A" and is, by reference, incorporated into this Decision.

This agreement has the effect of subordinating Application No. 35818 to filings held for various phases of the Central Utah Project with the exception of Application No. 36645, but also subordinates the use of all or part of the water under Application No. 35818 to Application No. 36645 after the year 2010 A.D.

Following receipt of this agreement a hearing was scheduled concerning those protests which were received during the extended period. In each case the protests were withdrawn with the understanding that the conditions set forth in the aforesaid agreement would be incorporated in the decision of this office.

It should be pointed out that the specific filings mentioned in the agreement are not all that is necessary to assure the successful completion of the Central Utah Project. There are other applications which were filed for the purpose of protecting existing uses within the Uintah Basin area which bear a priority subsequent to Application No. 35818. Unless these filings are given similar protection by subordination of Application No. 35818, existing users of water could be injured. Approval without such subordination would not be in the best public interest.

It is, therefore, ordered and Application No. 35818 is hereby APPROVED with a priority date of January 15, 1964, at 1:45 p.m. o'clock, subject to the following conditions:

1. The applicants shall take all reasonable precautions to prevent game fish from entering the intake facilities and to prevent ash, fly ash and other undesirable materials and poor quality water from the power plant from returning to Lake Powell.

2. The applications listed below, covering existing uses of water in the Uintah Basin, shall have priority to use the number of acre feet of water in any one year required for the irrigation of 1,061 acres (but the priority shall not exceed an aggregate of 4,244 acre-feet in one year for all applicants as a group) over the use of water by the applicants under Application No. 35818:

App. No.	Applicant	Priority
28483	J. Willis Moon	11:00 a.m. Nov. 19,1964
28484	Ray Thomas	" " " "
28485	Ray D. Broadhead	" " " "
28486	Clarence C. & Margaret Wright	" " " "
28492	Theron Robb	" " " "
28532	Farm Creek Irrigation Co.	" " " "
28533	Myrthen Moon	" " " "
28548	Ray D. Broadhead	" " " "
28549	Kenneth L.Wilkinson	" " " "
28581	Rocky Point Ditch Co.	" " " "
36542	Central Utah Water Consv. Dist.	" " " "
36543	" " " " "	" " " "
36544	" " " " "	" " " "
36545	" " " " "	" " " "
36546	" " " " "	" " " "
36547	" " " " "	" " " "
36548	" " " " "	" " " "
36549	" " " " "	" " " "
36550	" " " " "	" " " "
36551	" " " " "	" " " "
36552	" " " " "	" " " "
36553	" " " " "	" " " "
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36557	" " " " "	" " " "
36558	" " " " "	" " " "
36559	" " " " "	" " " "
36560	" " " " "	" " " "
36561	" " " " "	" " " "
36562	" " " " "	" " " "
36563	" " " " "	" " " "
36564	" " " " "	" " " "
36565	" " " " "	" " " "
36637	" " " " "	" " " "
36640	Dry Gulch Irrigation Co.	10:30 a.m. Nov. 27,1964
36641	Dry Gulch Irrigation Co.	10:30 a.m. Nov. 27,1964

This paragraph does not fix the duty of the water and does not constitute approval of the named applications but is limited to establishing the relative priorities as between the named applicants and the applicants under Application No. 35818.

3. The rights of the applicants under the seven applications listed below filed for the Initial Phase of the Central Utah Project, including the Uintah Unit of that Project, shall, as between the uses covered by said applications and the uses covered by Application No. 35818, have priority over the rights under Application No. 35818, provided, however, that the priority rights under said applications shall not in the aggregate exceed 700,000 acre-feet of diversions in any calendar year.

App. No.	Applicant	Unit	Priority
36638	U.S.Bureau of Rec.	Starvation Res.	12:00 Noon Nov.19,1964
36639	" " " "	Bonneville Unit	" " " " "
36642	" " " "	Upalco Unit	11:00 a.m. Nov.27,1964
36644	" " " "	Uintah Unit	9:00 a.m. Nov.27,1964
30416	" " " "	Uintah Unit	10:05 a.m. Aug. 7,1958
17558	" " " "	Jensen Unit	3:30 p.m. Apr.23,1946
30415	" " " "	Jensen Unit	10:05 a.m. Aug. 7,1958

4. The relative priorities of Application No. 35818 and Application No. 36645 and any and all applications which may hereafter be filed to implement the Ultimate Phase of the Central Utah Project shall be as set forth in Paragraphs III B, C and D of that certain agreement dated May 19, 1965, attached hereto as Appendix "A", and all other conditions of said agreement are hereby incorporated as conditions of this approval by reference thereto.

5. A certain Agreement between the United States of America, acting through the Bureau of Reclamation and the Bureau of Indian Affairs of the Department of Interior, the Ute Indian Tribe of the Uintah-Ouray Reservation, organized pursuant to the provisions of the Act of June 18, 1934 (48 Stat. 984, as amended), and the Central Utah Water Conservancy District, a public corporation, was executed by the parties thereto and became effective on September 2, 1965, (said Agreement being referred to as the "Indian Deferral Agreement", a copy of which is attached hereto as Exhibit "B"). The applicants **have, by letter dated August 31, 1965, a copy of which is attached hereto as Exhibit "C", recognized and acknowledged the priority of the rights of the Ute Indian Tribe to use Colorado River water to the extent of the irrigation requirements of the irrigable Indian water rights land described in the Indian Deferral Agreement and as set forth in the said letter of August 31, 1965.**

Therefore, the State Engineer APPROVES Application No. 35818 of Applicants, subject to said letter dated August 31, 1965.

6. The date for submitting Proof of Appropriation is hereby set for November 30, 1970. On or before this date the applicants are required to furnish to the State Engineer evidence that they have either commenced the construction or installation of facilities in connection with the first unit of the proposed power plant project or have let one or more of the contracts necessary to implement construction of the first unit. If such evidence has not been filed by that date, the State Engineer may give to the applicants notice to show cause why said application shall not be declared forfeited in whole or in part.

7. The applicants have indicated they have no intention of using water under this filing for any other purpose than for that described in the application. This approval is so conditioned that any part or all of the 120,000 acre-feet of water which is not used for the purposes specified in Application No. 35818 at the locations described in said application, or at changed locations approved as provided by law, shall be subject to use by other appropriators under their respective priorities.

102,000

8. The applicant companies should understand that this approval grants no easements or rights-of-way to obtain the water from Lake Powell and said companies must make any necessary arrangements with the appropriate agencies of the Federal Government to divert water from Lake Powell.

This decision is subject to all prior water rights and to the provisions of Section 73-3-14, Utah Code Annotated, 1954, which provides for plenary review by the filing of a civil action in the appropriate District Court within sixty days from date hereof.

Dated this 3rd day of September, 1965.

Hubert C. Lambert

Hubert C. Lambert
ACTING STATE ENGINEER

RKH/HCL/pbs/le

APPENDIX I- 8

Contract for Water Service from Lake Powell, dated October 2, 1969 (Contract No. 14-06-400-5139

APPENDIX I-8

Contract No. 14-06-400-5139
Conformed Copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GLEN CANYON UNIT
COLORADO RIVER STORAGE PROJECT
CONTRACT FOR WATER SERVICE FROM LAKE POWELL

THIS CONTRACT, made this 2nd day of October, 1969, pursuant to the Act of Congress approved June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto, all of which acts are commonly known and referred to as the Federal Reclamation Laws and particularly pursuant to the Act of Congress approved April 11, 1956 (70 Stat. 105), between THE UNITED STATES OF AMERICA, hereinafter referred to as the United States, represented by the officer executing this contract, his duly appointed successor, or his duly authorized representative, hereinafter referred to as the Contracting Officer and RESOURCES COMPANY, a corporation of the State of Arizona and a subsidiary of Arizona Public Service Company, with its principal office at Phoenix, Arizona, ASSOCIATED SOUTHERN INVESTMENT COMPANY, a corporation of the State of California and a subsidiary of Southern California Edison Company, with its principal office at Long Beach, California, and NEW ALBION RESOURCES COMPANY, a corporation of the State of California and a subsidiary of San Diego Gas & Electric Company, with its principal office at San Diego, California, hereinafter collectively referred to as the Contractor.

WITNESSETH:

WHEREAS, the following statements are made in explanation:

(a) The United States has constructed Glen Canyon Dam and Reservoir forming Lake Powell as a part of the Colorado River Storage Project, hereinafter referred to as Storage Project, and water service from Lake Powell can be furnished for industrial purposes.

(b) The Contractor needs water service from Lake Powell for use in connection with a steam electric generating plant and related facilities known as the Kaiparowits Power Project, which it plans to construct in the vicinity of Lake Powell.

NOW, THEREFORE, in consideration of the mutual and dependent covenants herein contained, the parties hereto agree as follows:

TERM OF CONTRACT

1. This contract shall be effective on the date first above written and shall remain in effect for a period of forty (40) years commencing on January 1 of the year in which water is first taken from Lake Powell under this contract or January 1, 1977, whichever occurs first.

RENEWAL OF CONTRACT

2. The Contractor shall have the right to renew this contract for one period of not to exceed twenty (20) years by giving the United States one (1) year's written notice prior to the end of the initial period, and Contractor shall have the right to renew the contract for additional periods of not to exceed forty (40) years each by giving the United States one (1) year's written notice prior to the end of the then existing period. The initial renewal shall be subject to renegotiation only of the charges set forth herein giving consideration to the circumstances prevailing at the time of renewal as provided in the Act of June 21, 1963 (P.L. 88-44; 77 Stat. 68), and any renewal or renewals after the initial twenty (20) year renewal shall be on terms and conditions mutually agreeable to the parties pursuant to the provisions of the said Act.

TERMINATION OF CONTRACT

3. This contract or any renewal thereof pursuant to Article 2 may be terminated:

(a) By the United States upon failure of the Contractor to perform its obligations under this contract. The United States will give the Contractor notice in writing of its intention to terminate this agreement and said notice shall specify each failure of the Contractor, and shall further provide that the Contractor may, within a one hundred twenty-(120) day period from the date of said notice, present the Secretary a detailed program to correct such deficiencies, and the Secretary shall accept such program subject to such conditions as he may reasonably impose, and thereby waive the termination notice.

(b) By the Contractor upon advance written notice of at least two (2) years prior to the requested termination date.

NON-USE OF WATER

4. The United States shall have the right to withdraw water service for that quantity of water which is not used in accordance with the schedule provided for in Article 7 for any continuous period of five (5) years unless, however, (i) such non-use resulted

from failure of the United States to provide the requisite water service, or (ii) Contractor has been prevented from using water because of uncontrollable forces, or (iii) Contractor has exercised reasonable diligence to take water service to the fullest extent permitted, consideration being given to economic conditions and good utility management. In the event of withdrawal, the Contractor shall have no further payment obligation with respect to the water service withdrawn.

CONSTRUCTION AND OPERATION OF FACILITIES

5. All pumps, pipelines, storage tanks, reservoirs, flood control and wasteway canals, waste area dams and reservoirs and other facilities required to take, measure and convey water to points of use, and to return water to Lake Powell, or to dispose of wastes from points of use hereinafter collectively referred to as facilities, shall be constructed or installed, operated and maintained by the Contractor at its sole expense. It is specifically recognized and agreed that this contract does not grant to the Contractor rights-of-way for the Kaiparowits Power Project on lands of the United States, but the Contractor will obtain such rights by application to the Secretary pursuant to Section 10 of the Reclamation Project Act of 1939 (53 Stat. 1196, 43 U.S.C.A. 387), as amended or other appropriate authority.

AVAILABILITY OF WATER SERVICE

6. The United States will furnish the Contractor water service during the term of this contract by permitting the Contractor to take from Lake Powell water annually in the amounts specified in Article 7 at such times as best suits the Contractor's needs at the location established in the rights granted the Contractor pursuant to Section 10 of the Reclamation Project Act of 1939, referred to in Article 5, or other appropriate authority, and the Contractor shall pay for the water service as provided in Article 8. It is recognized that pending completion of preliminary engineering and design studies, the location of the diversion works and works for the return of water cannot be determined and the Contractor and Contracting Officer shall cooperate in obtaining location therefor. The water service furnished shall be used by the Contractor only for the Kaiparowits Power Project and other purposes related to the operation of said project including, but not limited to, fuel production and ash disposal. The Contractor shall have no holdover storage rights in Lake Powell from year to year, and relinquishes its claim to any annual water service not utilized by December 31 of each year. Any water deliverable hereunder that is not called for by December 31 of each year shall become part of the following year's Storage Project water supply and be available for all Storage Project purposes in such year. It is understood and agreed that any sale, gift, delivery or other disposition of the whole or any part of said water by the Contractor to third parties shall be subject to the provisions set forth in Article 24.

WATER SCHEDULE

7. The Contractor's right to water service from Lake Powell shall be in accordance with the following schedule:

Year	Water to be Taken (Acre-Feet)
1977	3,825
1978	19,125
1979	30,600
1980	30,600
1981	30,600
1982	34,425
1983	49,725
1984	61,200
1985	61,200
1986	61,200
1987	66,300
1988	86,700
1989 and for each successive year thereafter	102,000

(a) Provided that:

(i) Commencing with the year 2011 A. D., the furnishing of water service in excess of 82,000 acre-feet per year shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase;

(ii) Commencing with the year 2021, the furnishing of water service in excess of 62,000 acre-feet per year shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase; and

(iii) Commencing with the year 2031, the furnishing of any water service shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase.

(b) The Contractor may from time to time increase the quantities of water to be taken under the above schedule, up to the maximum of one hundred and two thousand (102,000) acre-feet, or up to any lesser maximum quantity as has resulted from any relinquishment pursuant to Article 7(c) or withdrawal pursuant to Article 4 hereof, by giving six (6) months' written notice to the United States.

(c) The Contractor shall have the right to relinquish permanently a portion of its right to water service provided by this contract by giving two (2) years' written notice to the United States stating the quantity of water service to be relinquished. In the event of such relinquishment the Contractor shall have no further payment obligation with respect to the water service relinquished.

RATE AND METHOD OF PAYMENT

8. (a) During the initial forty-(40) year period of this contract, the Contractor shall pay for water service hereunder at the rate of Seven Dollars ($7.00) per acre-foot as scheduled in Article 7 or as the schedule may be increased or partially relinquished as provided in said article. Payments shall be made quarterly in advance in four (4) equal payments on January 1, April 1, July 1, and October 1 of each year commencing with the quarter in which water service is first furnished hereunder or the first quarter of the calendar year 1977, whichever occurs first; provided, however, that the Contractor shall not take any water from Lake Powell for which the Contractor has not paid in advance. Should there be any curtailment in water service pursuant to the provisions of Articles 4, 7, 11, 12, 17, or 18, a proportional adjustment in payments will be made.

(b) The Contractor shall pay to the United States on execution of this contract and thereafter each year on the anniversary of the effective date of this contract, an annual "readiness to serve" charge of thirty cents (30¢) per acre-foot each year for all contracted water for which the Contractor is not required to pay the $7.00 per acre-foot annual charge. This charge shall be an earnest money deposit to secure and reserve for the Contractor the right to water service provided in this contract. The accumulated earnest money deposits on quantities of water for which the Contractor commences paying the $7.00 rate shall be credited to payments due on such quantities of water. Should the contract be terminated for any reason, the remaining uncredited earnest money deposits shall become the property of the United States.

INTEREST UPON DELINQUENCY IN PAYMENT

9. Upon each charge to be paid by the Contractor to the United States pursuant to this contract which shall remain unpaid after the same shall become due and payable, there shall be imposed interest at the rate of one-half of one percent (1/2%) per month of the amount of such delinquent charge from and after the date when the same became due and until paid, and the Contractor hereby agrees to pay such interest; provided, that no interest shall be charged to the Contractor unless such delinquency continues for more than thirty (30) days; provided, further, that the United States reserves the right to withhold delivery of water at any time the Contractor is delinquent in payment beyond thirty (30) days.

MEASUREMENT AND RESPONSIBILITY FOR DISTRIBUTION

10. (a) The water to be furnished to the Contractor and the water to be returned to Lake Powell will be measured, delivered and returned by facilities constructed, operated and maintained by the Contractor, as approved by the United States, and such facilities so constructed, operated and maintained shall be accessible for inspection at all reasonable times by proper representatives of the United States. The Contractor agrees at its own expense to make any necessary arrangement for transportation of such water from Lake Powell to the place of use.

(b) The United States shall not be responsible for the control, carriage, handling, use or disposal of water furnished the Contractor hereunder, and the Contractor shall hold the United States harmless on account of damage or claim of damage of any nature whatsoever, including property damage, personal injury or death arising out of or connected with the Contractor's control, carriage, handling, use, disposal, or distribution of such water. The Contractor shall perfor[illegible] all acts necessary in order to maintain control of water [illegible]able to the Contractor.

WATER SERVICE SUBJECT TO COMPACTS, ACTS AND TREATY

11. This contract and all water delivery pursuant thereto shall be subject to and controlled by the applicable provisions of Colorado River Compact dated November 24, 1922, and proclaimed by the President of the United States, June 25, 1929; the Boulder Canyon Project Act approved December 21, 1928; the Boulder Canyon Project Adjustment Act of July 19, 1940; the Upper Colorado River Basin Compact dated October 11, 1948; and the Mexican Water Treaty of February 3, 1944. In the event the amount of water service hereunder is required to be curtailed under and by reason of the provisions of the foregoing acts, no liability shall attach to the United States for such curtailment. The Contractor agrees to a reduction of the amount of water service hereunder as the Secretary determines necessary to comply with the provisions of Article IV of the Upper Colorado River Basin Compact; provided, that commencing at the time in any year that it is determined that diversions from Lake Powell for use in Utah must be curtailed in order to comply with the provisions in said Compact Article IV, the United States, insofar as is practicable, will curtail diversions by subsequent contractors to minimize the need to curtail water diversions by or for the Contractor, and provided, further, that in no event will water service to the Contractor be reduced so long

as subsequent contractors for water service are diverting water from Lake Powell for use in Utah.

MAINTENANCE OF WATER LEVELS IN LAKE POWELL

12. The United States will normally operate Lake Powell so that the water level is maintained above elevation 3490 feet above mean sea level. However, the United States shall not be responsible for the maintenance of any particular water level in Lake Powell in order to permit the Contractor to take water therefrom through the facilities which it installs in accordance with Article 5. Charges shall be due and payable as provided in Article 8 irrespective of the Contractor's inability to take water except that if the water level drops below elevation 3490 and the Contractor is unable to withdraw water, the annual payments referred to in Article 8 will be proportionately adjusted to reflect the quantity of water service unavailable to the Contractor.

NONRESPONSIBILITY OF THE UNITED STATES FOR QUALITY OF WATER

13. The operation and maintenance of project facilities and the construction of new project facilities for the provision of project water under this contract shall be performed in such a manner as is practicable to maintain the quality of raw water to be furnished hereunder. The United States is under no obligation to construct or furnish water treatment facilities to maintain or to better the quality of water except to the extent such facilities are expressly referred to elsewhere in this contract as part of the project facilities to be constructed by the United States pursuant to reclamation law or as otherwise required by law. The United States is pursuing a program of water quality control as a national policy pursuant to the Federal Water Quality Act of 1965 and other similar legislation, including the establishment of and compliance with water quality standards, and will actively promote, support, and encourage the improvement of quality of water furnished hereunder. The Contractor, however, agrees that the United States assumes no liability should the water furnished hereunder be unsuitable for the Contractor's purposes.

WATER POLLUTION CONTROL

14. (a) The Contractor shall have the right to return water from the Kaiparowits Power Project to Lake Powell at locations and under measurement procedures approved by the Secretary so long as the temperature of such water shall not average more than 90° F., for any 24-hour period.

(b) The Contractor agrees that it will comply fully with all applicable Federal and State laws, orders and regulations, all as administered by appropriate authorities, concerning the pollution of streams, reservoirs, ground water, or water courses with respect to thermal pollution or the discharge of refuse, garbage, sewage effluent, industrial waste, oil, mine tailings, mineral salts, or other pollutants.

(c) The Contractor shall cause to be installed and diligently operated as part of the plant facilities, waste water, waste material and sewage control and disposal facilities. Plans and designs for waste water, waste material and sewage disposal shall be submitted to the Secretary in advance of construction, installation, or major modification of facilities. The Secretary shall in writing approve of or object to such plans and designs within sixty (60) days after such submission. In the event any objection cannot be resolved by mutual agreement within ninety (90) days of such submission, the matter shall be submitted to arbitration in accordance with the provisions of Article 16.

(d) The Contractor further agrees that any contract it may enter into with a third party for the furnishing or use of project water will contain this article.

AIR POLLUTION CONTROL

15. (a) To minimize smoke, fly ash, and dust in stack emissions, the Contractor shall procure and cause to be installed as part of the plant facilities, equipment specified to have a design efficiency for removal of particulate matter of ninety-nine and five-tenths percent (99.5%): PROVIDED, HOWEVER, That if the technology at the time of such procurement makes it impracticable for qualified vendors to meet such percentage with a commercially proven design, the Contractor shall be obligated to specify the highest percentage so proven at the time of such procurement. Such air-pollution control equipment shall be operated so as to remove not less than ninety-seven percent (97%) of the particulate matter in the stack emissions in each month and not less than ninety-six percent (96%) thereof in any twenty-four (24) hour period, unless uncontrollable forces prevent such operation. Designs and plans for the air pollution control equipment, stack, and other plant features that may affect air pollution, and facilities for control and disposal of waste or residue from burned fuel shall be submitted to the Secretary in advance of construction, installation, removal, or major modification thereof. The Secretary shall in writing approve of or object to the aforesaid designs, plans, equipment or features or the major modification or supplementation thereof, within sixty (60) days of such submission. In the event any objection cannot be resolved by mutual agreement within ninety (90) days of such submission, the matter shall be submitted to arbitration in accordance with the

provisions of Article 16. In the event that the Secretary fails to act within sixty (60) days of such submission, the Secretary shall be deemed to have given his approval. The Secretary's approval of such designs and plans shall not be deemed by implication or otherwise to relieve the Contractor of the obligation to meet operating [illegible] set forth in this article. From time to time, but not [illegible] than once in every ten (10) years, the designated representatives of the Secretary and the Contractor will meet to review technological advances in air pollution control equipment and mutually weigh and decide upon the feasibility of installing additional equipment or modifying existing equipment in the plant facilities, taking into account cost as well as benefits of improved air pollution control.

(b) In the operation of the plant facilities utilizing the contracted water, the Contractor will make or cause to be made such tests and measurements and keep or cause to be kept such records as will enable the Contractor to make accurate and complete reports to the Secretary relating to the operation and efficiency of the air pollution control equipment. Said reports shall be furnished to the Secretary not less often than once in each calendar year. Any continuous recording equipment will be calibrated against test performed in conformance with American Society of Mechanical Engineers (ASME) Test Procedures for Determining Dust Concentration in a Gas Stream unless some other procedure for making such tests and measurements may be mutually agreed upon. Such test procedures will be conducted at least every six (6) months. Contractor shall also furnish the Secretary with monthly reports showing the average monthly assay of the ash and sulphur content of the coal used.

(c) During normal working hours, representatives of the Secretary shall have access to, the right to inspect, and to copy, all records relating to air pollution from the plant facilities, and such representatives shall have the right to enter upon and inspect such plant facilities and all parts thereof and appurtenances thereto.

(d) The thermal-electric generating plant facilities utilizing the water under this contract shall be fueled with Utah coal mined in the Kaiparowits field and/or the Kanab field, or derivaties therefrom, unless the Secretary approves the use of other coal and derivatives therefrom. The Contractor will furnish quantitative data on ash and sulphur content of said coal as a part of the design and plans referred to in Article 15(a). It is understood and agreed that natural gas and oil may be used as an auxiliary fuel in operating the thermal-electric generating plant utilizing water furnished under this contract.

(e) Nothing herein shall be construed to relieve the water user from complying with all valid, applicable air pollution control laws and regulations under Federal, State or County jurisdiction now or hereafter in force.

ARBITRATION

16. Whenever a controversy arises as to which arbitration is provided for and such controversy cannot be resolved by the Secretary and the Contractor, either of said parties by written notice to the other may require such controversy to be submitted to arbitration. Within thirty (30) days from the date of the notice the Secretary and the Contractor shall each name one arbitrator and the two arbitrators so selected shall within sixty (60) days from the date of said notice select a third arbitrator. In the event that either party has not appointed its arbitrator within the specified thirty-(30) day period, then the other party may make application to the appropriate United States District Court for Utah for the appointment of an arbitrator for the party failing to act. In the event of the failure of the two arbitrators to select the third arbitrator either the Secretary or the Contractor may make application to the appropriate United States District Court for Utah for the appointment of the third arbitrator substantially in accord with the procedure provided in the Federal Arbitration Act (9 U.S.C.A. 1). It is understood and agreed that the Secretary and the Contractor shall each bear the costs and expenses of its respective arbitrator, and the cost and expense of the third arbitrator together with all other costs and expenses incident to said arbitration shall be shared equally by the parties. The decision of any two of the three arbitrators shall be a valid and binding award of the arbitration. The arbitrators shall render a decision within one hundred and eighty (180) days of the time of submission of the controversy to arbitration. In event of a determination that arbitration is not binding on the United States, any matter referred to arbitration shall be referred to a court of competent jurisdiction.

UNCONTROLLABLE FORCES

17. Neither party shall be considered to be in default in respect to any obligation hereunder, if prevented from fulfilling such obligation by reason of uncontrollable forces, the term "uncontrollable forces" being deemed for the purposes of this contract, to mean any cause beyond the control of the party affected, including, but not limited to, drouth, failure of facilities, flood, earthquake, storm, lightning, fire, epidemic, war, riot, civil disturbance, labor disturbance, sabotage and restraint by court or public authority, which by exercise of due diligence and foresight, such party could not reasonably have been expected to avoid. Either party rendered unable to fulfill any obligation by reason of uncontrollable forces shall exercise due diligence to remove such inability with all reasonable dispatch.

UNITED STATES NOT LIABLE FOR WATER SHORTAGE

18. On account of uncontrollable forces, there may occur at times a shortage during any year in the quantity of water available for furnishing to the Contractor by the United States pursuant to this contract through and by means of the project, and in no event shall any liability accrue against the United States or any of its officers, agents or employees for any damage, direct or indirect, arising therefrom.

CONTRACTOR TO KEEP BOOKS AND RECORDS

19. The Contractor shall establish and maintain accounts and other books and records sufficient to enable it to furnish, and the Contractor will furnish to the Contracting Officer, upon his request, reports and statements as to the Contractor's operations pertaining to this contract.

INSPECTION OF BOOKS AND RECORDS

20. Subject to applicable Federal laws and regulations, the proper officers or agents of the Contractor shall have full and free access at all reasonable times to the Storage Project account books and official records of the Bureau of Reclamation, insofar as the same pertain to the matters and things provided for in this contract, with the right at any time during office hours to make copies thereof, and proper representatives of the United States shall have similar rights with respect to the account books and records of the Contractor as such pertain to this contract.

CONTINGENT UPON APPROPRIATIONS OR ALLOTMENTS OF FUNDS

21. The expenditure of any money or the performance of any work by the United States herein provided for which may require appropriations by the Congress or the allotment of funds shall be contingent upon such appropriations or allotments being made. The failure of the Congress to appropriate funds or the failure of an allotment of funds shall not relieve the Contractor from any obligations under this contract except as otherwise provided herein, and no liability shall accrue to the United States in the event such funds are not so appropriated or allotted.

REMEDIES - WAIVERS

22. Nothing contained in this contract shall be construed as in any manner abridging, limiting or depriving either party to this contract of any means of enforcing any remedy, either at law or in equity, for the breach of any of the provisions hereof which it would otherwise have, provided, prior notices as herein agreed have been given. Any waiver at any time by either party to this contract of its rights with respect to any default, or any other matter arising in connection with this contract, shall not be deemed to be a waiver with respect to any subsequent default or matter.

OFFICIALS NOT TO BENEFIT

23. No Member of or Delegate to Congress or Resident Commissioner and no officer, agent, or employee of the United States Department of the Interior shall be admitted to any share or part of this contract or to any benefit that may arise herefrom, but this restriction shall not be construed to extend to this contract if made with a corporation or company for its general benefit.

ASSIGNMENT LIMITED: SUCCESSORS AND ASSIGNS OBLIGATED

24. The provisions of this contract shall apply to and bind the successors and assigns of the respective parties, but no voluntary assignment or transfer of this contract or any part thereof or interest therein shall, except as hereinafter provided, be valid unless and until approved by the Contracting Officer. Upon any transfer of interest as to which approval by the Contracting Officer is not required or in the case of any transfer which shall have been approved by the Contracting Officer, such company or companies comprising the Contractor which have effected such transfer of interest shall no longer be obligated to the United States to keep and perform the conditions and covenants in this contract on their part to be kept and performed insofar as such obligations have been transferred, except in the case of any transfer which results as a consequence of the enforcement of rights conferred by trust indentures, mortgages, trust deeds, security agreements or other instruments for purposes of security, as provided below:

The execution of trust indentures, mortgages, trust deeds, security agreements or other instruments for purposes of security, or trustee's sale made thereunder, and the transfer and assignment of interests in this agreement to a trustee or trustees under such trust indentures, mortgages, deeds of trust, security agreements or other instruments for purposes of security, and to any successors or assigns thereof, or any receiver, referee or trustee in bankruptcy or receivership or reorganization of any of the companies comprising the Contractor, or any successor by action of law, or any purchaser, transferee or assignee of any thereof, shall not be deemed to be a voluntary transfer within the meaning of this section and shall not require approval by the Contracting Officer. Any trustee, successor or assignee of the rights of any of the companies comprising the Contractor, whether by voluntary transfer or otherwise, shall be subject to all provisions and conditions of this contract to the same extent as though the transferee, successor or assignee were an original Contractor hereunder, except that any such trustee, successor or assignee who succeeds to the interest of any company comprising the Contractor as a consequence of the enforcement of rights conferred by any trust indenture, mortgage, trust deed, security agreement or other instrument for purpose of security executed by such company or its predecessor in interest shall not be liable for any obligation to pay money owing under this contract by such company which obligation arose prior to the date on which any such trustee, successor or assignee succeeds to the interest of such company, and the interest of such successor shall not be subject to any such obligation to pay money owing, but any such obligation shall be and remain the obligation of such company.

Each of said companies comprising the Contractor shall have the right to transfer or assign in whole or in part its interests in this contract, without need for consent of the United States, at any time (i) to any of the other company or companies constituting the Contractor hereunder, or (ii) to the parent companies of which said companies are subsidiaries. In addition, each of said companies comprising the Contractor shall have the right to transfer or assign an undivided interest in this contract without need for consent of the United States at any time to any corporation, cooperative or political subdivision or public agency participating with the Contractor in the ownership and operation of the Kaiparowits Power Project, including, but not limited to, the production, processing or transportation of fuel therefor. Any such successor shall become subject to all the obligations of the transferor or assignor company hereunder and any such transferor or assignor shall notify the United States of such transfer, assignment or reassignment and shall furnish the United States evidence of such transfer, assignment or reassignment.

The companies comprising the Contractor shall not receive any valuable consideration for any assignment in excess of previous payments by the Contractor to the United States for rights to water delivery which have not been used and which are assigned to the assignee. The Contractor shall not exact any brokerage, commission, or fee from any person on the assignment of any rights to water delivery under this contract. In connection with any assignment, the President or Chairman of the Board of the company making the assignment shall certify to the Contracting Officer that the assignment with respect to water delivery was without consideration except as provided above, and that no brokerage, commission, fee, or other charge of any kind was charged to the assignee or any person acting on behalf of the assignee on account of such assignment. The Contractor shall maintain books, records, documents, and all other evidence pertaining to any assignment of rights under this contract, and the Contracting Officer shall have access to and the right to examine any books, records, documents or other evidence of the Contractor involving any transaction, including assignment, related to this contract.

NOTICES

25. (a) Any notice authorized or required to be given to the United States shall be deemed to have been given when mailed, postage prepaid, or delivered to the Regional Director, Region 4, Bureau of Reclamation, United States Department of the Interior, P. O. Box 11568, Salt Lake City, Utah 84111. Any notice authorized or required to be given to the Contractor shall be deemed to have been given when mailed, postage prepaid, or delivered to Vice President and General Manager, Resources Company, P. O. Box 20824, Phoenix, Arizona 85036.

(b) The designation of the addressee or the address given above may be changed by notice in the same manner as provided in this article for other notices.

EQUAL OPPORTUNITY

26. The provisions of Title 42 U.S.C. 2000-e-2(i) provide for the giving of preference to Indians in employment. Except as therein provided and in keeping with any obligation undertaken or which may be undertaken by any of the corporations comprising the Contractor, or their assignees, pursuant to the terms of said Title 42 U.S.C. 2000-e-2(i) to give preference for employment to qualified Indians for work on or near an Indian Reservation during the performance of this contract the Contractor agrees as follows:

(a) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this Equal Opportunity clause.

(b) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(c) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency Contracting Officer, advising the labor union or workers' representative of the Contractor commitments under the Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The Contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor.

(e) The Contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.

(f) In the event of the Contractor's noncompliance with the Equal Opportunity clause of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(g) The Contractor will include the provisions of the paragraphs (a) through (g) in every subcontract or purchase order unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions; including sanctions for noncompliance; Provided, however, that in the event the Contracto becomes involved in, or threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

UNITED STATES OPTION TO PARTICIPATE IN KAIPAROWITS POWER PROJECT

27. (a) The United States shall have the option to acquire an entitlement to a portion of the thermal generating capacity of the Kaiparowits Power Project, including an entitlement to transmission capacity for delivery of power and energy therefrom to the Central Arizona Project on terms and conditions to be negotiated in good faith by the proposed participants in the Kaiparowits Power Project, including the United States. The purpose of this option is to enable the United States to acquire all the power and energy or a portion thereof necessary to supply the Central Arizona Project pumping requirements, in accordance with the provisions of Section 303 of the Colorado River Basin Project Act (Public Law 90-537), in the event the United States has not, by the time the Kaiparowits Power Project is to be constructed, acquired such power and energy from another source.

(b) No water shall be delivered under this contract until either (i) the United States has acquired a supply of power and energy sufficient to supply the Central Arizona Project pumping requirements from a source other than the Kaiparowits Power Project; or (ii) an agreement has been executed that includes the United States as a participant in the Kaiparowits Power Project in accordance with Section 303 of the Colorado River Basin Project Act (Public Law 90-537); or (iii) the United States has been invited to join in good faith negotiations of such an agreement and has declined to do so. Such invitation shall not be made earlier than eighteen (18) months following execution of this contract and the United States shall respond within three (3) months after receiving said invitation. If a determination of feasibility has not been completed by June 1972, the Contractor shall advise the United States of the estimated completion date of said determination and the estimated date of on-line operation of the Kaiparowits Power Project.

IN WITNESS WHEREOF, the parties hereto have signed their names the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

RESOURCES COMPANY

ATTEST:

/s/ Wm. T. Quinsler
Secretary

(SEAL)

By /s/ M. C. Titus
Vice President and General Manager

ASSOCIATED SOUTHERN INVESTMENT COMPANY

ATTEST:

/s/ J. C. Bobek
Secretary

(SEAL)

By /s/ J. K. Horton
Vice President

NEW ALBION RESOURCES COMPANY

ATTEST:

/s/ W. A. Zitlau
Vice President and Treasurer

(SEAL)

By /s/ W. A. Zitlau
Vice President and Treasurer

APPENDIX I- 9

Kaiparowits and Navajo Mutual Assistance Agreement
Between the United States of America and
San Diego Gas & Electric Company and
Southern California Edison Company
dated October 2, 1969
(Contract No. 14-06-400-5160)

APPENDIX I-9

Conformed Copy
Contract No. 14-06-400-5160

KAIPAROWITS AND NAVAJO MUTUAL ASSISTANCE AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND SAN DIEGO GAS & ELECTRIC COMPANY AND SOUTHERN CALIFORNIA EDISON COMPANY

1. THIS AGREEMENT made as of the 2nd day of October, 1969, between the UNITED STATES OF AMERICA, party of the first part (hereinafter called the United States), acting through the Secretary of the Interior (hereinafter called the Secretary), or his duly authorized representative, and SAN DIEGO GAS & ELECTRIC COMPANY, a California corporation (hereinafter sometimes called San Diego) and SOUTHERN CALIFORNIA EDISON COMPANY, a California corporation (hereinafter sometimes called Edison), parties of the second part (hereinafter sometimes called collectively Companies and individually Company).

2. WHEREAS, the United States intends to acquire an entitlement to capacity in coal-fired steam electric generating units under the terms of Section 303 of the Colorado River Basin Act (PL 90-537) and it is expected that such units will be part of a power plant proposed to be built by others and to be known as the Navajo Project; and

3. WHEREAS, the Companies with others intend to construct a coal-fired steam electric generating plant in southern Utah to be known as the Kaiparowits Project; and

4. WHEREAS, the United States and Companies intend to provide mutual assistance in times of unit outages at the Kaiparowits and Navajo Projects through the exchange of capacity and associated energy between the first three generating units of the Navajo Project and the first three generating units of the Kaiparowits Project.

5. NOW, THEREFORE, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

6. The United States shall have the option to participate in mutual assistance with Companies under conditions hereinafter provided through the exchange of capacity and associated energy to be supplied from the capacity entitlement of the United States in one or more of the first three generating units of the Navajo Project with capacity and associated energy to be supplied from the capacity entitlements of the Companies in one or more of the first three generating units of the Kaiparowits Project. Such option may be exercised only in the event (i) one or more generating units are constructed at the Navajo Project, and the United States has an entitlement to capacity in such unit or units, and (ii) Companies notify United States pursuant to paragraph 7 that one or more generating units are to be constructed by Companies at the Kaiparowits Project and the United States does not elect to exercise the option contained in Article 27 of Contract No. 14-06-400-5139 to acquire an entitlement to a portion of the thermal generating capacity in the Kaiparowits Project.

7. The Companies will notify the United States in advance of making commitments for the construction of each of the first three generating units at Kaiparowits Project and United States shall have six (6) months following the time of such notification within which to exercise the above mentioned option with respect to that unit, provided that no such notification by Companies shall be given prior

to June 1, 1971.

8. If the United States exercises the option acquired by it hereunder, a mutual assistance contract shall be negotiated in good faith between the United States and Companies, and shall provide, in addition to the usual terms and conditions of such a contract, for an exchange of capacity and associated energy, upon substantially the following terms and conditions:

(a) Capacity and energy acquired by the United States through such mutual assistance shall only be used for purposes permitted by Section 303 of the Colorado River Basin Act (PL 90-537).

(b) Whenever one or more of the Designated Navajo generating units is out of service due to a forced outage or scheduled outage for necessary maintenance, the United States shall be entitled to schedule capacity and associated energy from the Companies' entitlement in the Kaiparowits Project during each hour of such outage, and to receive such capacity and energy at mutually agreed upon delivery points in amounts equal to the product of the Mutual Assistance Percentage times the amount of capacity and associated energy it would be entitled to have generated for its account on such unit or units as are out of service at the Navajo Project, reduced, however, by the proportion by which the aggregate capacity entitlement of the Companies in the Designated Kaiparowits generating units is curtailed or out of service at the time.

(c) Whenever one or more of the Designated Kaiparowits generating units is out of service due to a forced outage or scheduled outage for necessary maintenance, the Companies shall be entitled to schedule capacity and associated energy from the United States' entitlement in the Navajo Project during each hour of such outage, and to receive such capacity and associated energy at mutually agreed upon delivery points in amounts equal to the product of the Mutual Assistance Percentage times the amount of capacity and associated energy which the United States would be entitled to have generated for its account on such number of units at the Navajo Project, reduced, however, by the proportion that the capacity entitlement of the United States in the Designated Navajo units is curtailed or out of service at the time.

(d) San Diego and Edison shall be obligated to provide capacity and associated energy to the United States pursuant to paragraph 8(b) hereof in the proportion that their individual capacity entitlements, if any, in the Designated Kaiparowits generating units in service at that time bears to the combined capacity entitlements of the Companies in such units. San Diego and Edison shall be entitled to receive capacity and associated energy from the United States pursuant to paragraph 8(c) hereof in the proportion that their individual capacity entitlements, if any, in the Designated Kaiparowits generating units out of service at that time bears to the combined capacity entitlements of the Companies in such units.

(e) The United States shall be obligated to pay San Diego and Edison monthly for the fuel cost incurred by each Company in the generation at Kaiparowits and transmission of the energy which the United States has received hereunder from such Company during the preceding month.

(f) Each Company shall be obligated to pay the United States monthly the fuel cost incurred by the United States in the generation at Navajo and transmission of the energy which it has received hereunder from the United States during the preceding month.

(g) The "Designated" units referred to in this Agreement shall be either: (i) The first three units constructed and placed in commercial operation at the Navajo Project in which the United States has a capacity entitlement and the first three units constructed and placed in commercial operation at the Kaiparowits Project in which one or both of the Companies has a capacity entitlement, or (ii) Prior to the time that there are three such units at both of the Projects, the "Designated" units shall consist of the units in the Project having the lesser number of such units and an equal number of units, specifically designated in the Project having the greater number of such units by the party or parties having a capacity entitlement therein. Such designation may only be changed by mutual agreement.

(h) If the combined capacity entitlement of the Companies in the Designated units of the Kaiparowits Project is less than the combined capacity entitlement of the United States in the Designated units of the Navajo Project then, for purposes of this paragraph 8, the capacity entitlement of the United States in the Designated units of the Navajo Project shall be deemed to be equal to the capacity entitlement of the Companies in the Designated units of the Kaiparowits Project.

(i) If the United States exercises the option acquired by it hereunder, the parties hereto shall, at the time of first exercising such option, select the "Mutual Assistance Percentage" which, unless otherwise agreed to, shall not exceed 50% and shall not be less than 15% and shall not thereafter be changed. Such Mutual Assistance Percentage shall be applicable to both subparagraphs 8(b) and 8(c). If the United States enters into mutual assistance agreements or similar agreements with others, the United States shall not therein commit capacity or associated energy from its entitlement in the Designated units at the Navajo Project, which when totaled and added to the capacity and associated energy committed by it pursuant to the exercise of this option, would exceed one-half of the United States' entitlement in such Designated units.

(j) The mutual assistance contract shall not be effective prior to the date of first pumping on the Central Arizona Project and thereafter shall not apply to a Company while it is receiving an assignment of capacity and energy from the United States' entitlement in the Navajo Project.

9.1 In consideration of the option provided to the United States in Article 27 of Contract No. 14-06-400-5139, to acquire an entitlement in a portion of the thermal generating capacity of the Kaiparowits Project and the option provided to the United States under this Agreement to enter into a mutual assistance contract with the Companies, the Secretary hereby finds that such options are more advantageous to the United States than the obligations provided for in 43 CFR 2234.1-3(c) (13) and 2234.4-1(c) (5) (ii); 36 CFR 251.52(d) (2); 25 CFR 161.27(f) (2); F.R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520. Neither Company shall be required to include in any application for a grant of a right of way for facilities to be used in transmitting capacity and energy from the Kaiparowits Power Project to its respective load center, nor shall there be included in any grant of right of way issued for facilities to be used in transmitting capacity and associated energy from the Kaiparowits Project to the load centers of the Companies, any stipulation, covenant or obligation provided for in 43 CFR 2234.1-3(c) (13) and 2234.4-1(c) (5) (ii); 36 CFR 251.52(d) (2); 25 CFR 161.27(f) (2); F.R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520, as such provisions now exist or are hereafter amended or superseded, or any similar stipulation, covenant or obligation. The Secretary will not require to be retained in any prior application of San Diego or Edison and will modify any prior grant applicable to rights of way for facilities to be used in transmitting capacity and associated energy from the Kaiparowits Power Project so as to eliminate from said applications and grants applicable to said rights of way for the terms of said grants, any stipulation, covenant or obligation provided for in the above mentioned regulation.

9.2 As used in paragraph 9.1, the phrase "facilities to be used in transmitting power and energy" shall be those transmission lines and related facilities constructed, reconstructed or relocated prior to January 1, 1990, for operation at 115 kv or above which will transmit power and energy from the Kaiparowits Power Project to the load centers of the Companies, or may be desirable or necessary to make the transmission of such power and energy reliable in accordance with good utility practices.

10. This Agreement will be governed by the law of the State of California and applicable Federal law.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

ATTEST:

/s/ C. Hayden Ames
Assistant Secretary

(SEAL)

SAN DIEGO GAS & ELECTRIC COMPANY

By /s/ W. A. Zitlau
Executive Vice President

ATTEST:

/s/ J. C. Bobek
Assistant Secretary

(SEAL)

SOUTHERN CALIFORNIA EDISON COMPANY

By /s/ J. K. Horton
Chairman of the Board

APPENDIX I-10

Kaiparowits Power Coordination Contract,
Dated October 2, 1969
(Contract No. 14-06-400-5161

APPENDIX I- 10 Contract No. 14-06-400-5161

Conformed Copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
KAIPAROWITS POWER COORDINATION CONTRACT

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1. This contract, made as of the 2nd day of October, 1969, between THE UNITED STATES OF AMERICA, party of the first part (hereinafter called the "United States"), acting through the Secretary of the Interior (hereinafter called the "Secretary"), or his duly authorized representative, and ARIZONA PUBLIC SERVICE COMPANY, an Arizona corporation; SAN DIEGO GAS & ELECTRIC COMPANY, a California corporation; SOUTHERN CALIFORNIA EDISON COMPANY, a California corporation; parties of the second part (hereinafter called the non-Federal Parties),

2. WHEREAS, the parties hereto desire to coordinate, as hereinafter provided, the thermal-electric systems of the non-Federal Parties with the Colorado River hydroelectric system of the United States; and

3. WHEREAS, the United States, acting through the Secretary of the Interior or his duly authorized representative, is authorized to enter into arrangements for the marketing of electric power pursuant to the Federal Reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof and supplementary thereto); and

4. WHEREAS, the parties hereto have been negotiating the terms and conditions of an agreement whereby among other things the non-Federal Parties would sell to the United States energy to firm up the hydroelectric facilities of the Colorado River Storage Project and the Parker-Davis projects and whereby the non-Federal Parties would purchase from the United States surplus energy from said hydroelectric facilities. However, due to the complexity of the problems with respect thereto, the parties have not, as of the date of execution of this contract, been able to reach agreement on all matters with respect thereto, and while the parties hereto are willing to continue negotiations in an effort to reach agreement on all matters with respect thereto on or before July 1, 1970, the parties desire to enter into this contract.

5. NOW, THEREFORE, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

ARTICLE 6

SALES AND PURCHASES OF ENERGY

6.1 Should a non-Federal Party desire to purchase energy from the United States at the point or points of delivery to be agreed upon by authorized representatives of the non-Federal Party and the United States, the United States agrees to supply such amounts of energy as the United States in its sole judgment desires to sell and the non-Federal Party desires to purchase.

6.2 Should the United States desire to purchase energy from a non-Federal Party at the point or points of delivery to be agreed upon by authorized representatives of the United States and the non-Federal Party, said Party agrees to supply such amounts of energy as the non-Federal Party in its sole judgment desires to sell and the United States desires to purchase.

6.3 The United States and any non-Federal Party may enter into transactions for the interchange of energy. A record of energy interchanges shall be maintained by each party to any such transaction and no energy deliveries by one party to the other party shall be deemed to be interchange energy unless prior agreement for such deliveries has been made between the authorized representatives of the parties to the transaction. Unless otherwise agreed by the authorized representatives of the parties to the transaction, the interchange energy account shall be balanced by return on a kilowatt-hour for kilowatt-hour basis as promptly as circumstances permit. The authorized representatives of the parties to such interchange transactions shall agree in advance of any such transactions on the terms for settling unbalanced accounts.

6.4 All deliveries of energy pursuant to this Article 6 shall be at such times, rates, and points of delivery and such conditions as may be mutually agreed upon by the parties to the transaction and shall be interruptible without notice.

ARTICLE 7

RATES

7.1 All charges for energy pursuant to Articles 7.2 and 7.3 hereof shall be adjusted for transmission costs and for any applicable governmental impositions or taxes.

7.2 The rate for energy sold by a non-Federal Party to the United States pursuant to Article 6.2 hereof shall be 115% of the incremental production cost to the selling non-Federal Party of such energy delivered to the point or points of delivery, as quoted to the United States from time to time by that non-Federal Party prior to the delivery of the energy, or at such other time as may be mutually agreed to by the United States and the selling non-Federal Party. The incremental production cost shall be the estimated expense incurred by the selling non-Federal Party in generating the energy required to make such sale which expense shall be the sum of the following items divided by the number of kilowatt-hours of energy sold:

7.2.1 The estimated replacement cost of fuel used to generate the energy required to make such sale, plus

7.2.2 For operation and maintenance, 0.2 mills per kilowatt-hour of energy generated, plus

7.2.3 The estimated cost of making ready, starting up and shutting down such units as would necessarily be started to make such sale, including the estimated cost of zero net-load fuel.

7.3 The rate for energy sold by the United States to a non-Federal Party pursuant to Article 6.1 hereof shall be 85% of the decremental production value to the purchasing non-Federal Party of such energy at the point or points of delivery, as quoted to the United States from time to time by that non-Federal Party prior to the receipt of the energy, or at such other time as may be mutually agreed to by the United States and the purchasing non-Federal Party. The decremental production value shall be the estimated expense which would otherwise have been incurred by the purchasing non-Federal Party in generating energy in place of such purchase, which value shall be the sum of the following items divided by the number of kilowatt-hours of energy purchased:

7.3.1 The estimated replacement cost of fuel which would have been used to generate energy in place of such purchase, plus,

7.3.2 For operation and maintenance, 0.2 mills per kilowatt-hour of energy which would have been generated, plus,

7.3.3 The estimated cost of making ready, starting up and shutting down such units as would necessarily have been started to make the replaced energy available, including the estimated replacement cost of zero net-load fuel.

ARTICLE 8

NONDEDICATION OF FACILITIES

8.1 Any non-Federal Party, prior to entering into transactions with the United States hereunder, shall have made transmission arrangements satisfactory to it necessary for such transactions.

8.2 This contract shall not be construed to grant the non-Federal Party any rights of ownership in, or possession of, or control over the electric system of the United States.

8.3 This contract shall not be construed to grant the United States any rights of ownership in, or possession of, or control over the electric system of any non-Federal Party.

8.4 The non-Federal Parties do not intend to dedicate, and nothing in this contract shall be construed as constituting a dedication by any non-Federal Party of its properties or facilities or any part thereof, to the United States or to any other non-Federal Party, or to the customers of the United States or to the customers of any other non-Federal Party.

ARTICLE 9

BILLING AND PAYMENTS

9.1 The accounting period for all transactions entered into pursuant to this contract shall be one (1) month. The closing date shall be as mutually agreed to between the United States and the non-Federal Parties. Unless otherwise mutually agreed, bills for amounts payable for any month shall be submitted by the supplying party at the close of each billing period and such bills shall be due and payable within thrity (30) days following receipt of such bill.

ARTICLE 10

TERM OF CONTRACT

10.1 This contract shall become effective when it has been duly executed and delivered by all of the parties hereto; and shall remain in effect until December 31, 2026.

ARTICLE 11

RIGHTS-OF-WAY

11.1 If the United States participates in the Kaiparowits Project as provided for in Article 27 of Contract No. 14-06-400-5139, the Secretary hereby finds that the provisions hereof are more advantageous to the United States than the obligations provided for in 43 CFR 2234.1-3(c)(13) and 2234.4-1(c)(5)(ii); 36 CFR 251.52(d)(2); 25 CFR 161.27(f)(2); F. R. Doc. 67-3666, filed April 3, 1967, 32 F. R. 5520. Therefore, if the United States participates, during the term of this contract, no non-Federal Party shall be required to include in any application for a grant of a right-of-way for facilities to be used in transmitting power and energy from the Kaiparowits Power Project to their respective load centers, nor shall there be included in any grant of right-of-way issued pursuant to such an application, any stipulation, covenant or obligation provided for in 43 CFR 2234.1-3(c)(13) and 2234.4-1(c)(5)(ii); 36 CFR 251.52(d)(2); 25 CFR 161.27(f)(2); F. R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520; as such provisions now exist or are hereafter amended or superseded, or any similar stipulation, covenant or obligation. The Secretary, upon the effective date of this contract, will also not require to be retained in any application and will modify any grant applicable to rights-of-way for facilities to be used in transmitting power and energy from the Kaiparowits Power Project filed or granted prior to the effective date of this contract so as to eliminate from said applications and grants applicable to said rights-of-way for the terms of said grants, any stipulation, covenant, or obligation provided for in the above-mentioned regulations.

11.2 As used in this Article 11, the phrase "facilities to be used in transmitting power and energy" shall be those transmission lines and related facilities constructed, reconstructed or relocated prior to January 1, 1990, for operation at 115 kv or above which will transmit power and energy from the Kaiparowits Power Project to the load centers of the non-Federal Parties, or which may be desirable or necessary to make the transmission of such power and energy reliable in accordance with good utility practice.

ARTICLE 12

OBLIGATIONS SATISFIED

12.1 This contract, together with the option provided to the United States in Article 27 of Contract No. 14-06-400-5139 to participate in the Kaiparowits Power Project, fulfills and satisfies any and all obligations that the United States and any non-Federal Party and any subsidiary thereof may have arising out of the exchange of correspondence between the Secretary of the Interior and the President of Southern California Edison Company, dated April 7, 1966, and April 11, 1966, respectively (attached hereto as Exhibits A and B). Satisfying the foregoing obligations is not necessarily to be interpreted as amending, changing, or satisfying in any manner the requirements of Article 28 of the contract of January 17, 1969, between the United States and the Salt River Project Agricultural Improvement and Power District, Contract No. 14-06-400-5033; Article 5 of the contract of April 11, 1968, between the United States and Utah Construction and Mining Company, Contract No. 14-06-400-4831; Article 5 of the contract of April 11, 1968, between the United States and Public Service Company of New Mexico, Contract No. 14-06-400-4821. Any revision, modification or termination of this contract and any default by a party hereunder or cancellation or termination of the contract by any party hereto shall not in any manner revive, recreate, or reinstate any of the terms, covenants and conditions in the aforementioned letters nor the obligations of any non-Federal Party with regard thereto satisfied by this Article 12, except by written consent of all the parties to this contract.

ARTICLE 13

TRANSACTIONS OUTSIDE THIS CONTRACT

13.1 Nothing contained in this contract shall preclude any party from entering into transactions with any entity for the sale or purchase of energy upon terms and conditions other than those set forth in Articles 6 and 7 hereof.

ARTICLE 14

NO AMENDMENT OF OTHER CONTRACTS

14.1 Except with respect to the exchange of correspondence described in Article 12.1, nothing contained in this contract shall be construed to alter, modify or in any manner affect the rights or obligations of any party hereto to any other party hereto or to third parties under any other contract.

ARTICLE 15

COORDINATION COMMITTEE

15.1 A Coordination Committee shall be established consisting of one representative from each of the parties to this contract. Each representative shall have one alternate. The Coordination Committee shall be responsible for administering this contract and establishing procedures to implement this contract. All actions of the Coordination Committee shall be by unanimous action and shall be reduced to writing. The Coordination Committee shall appoint such subcommittees and establish such work groups as it considers necessary.

15.2 In addition to its other duties as set forth in this contract, the Coordination Committee shall establish standard practices and procedures for:

15.2.1 Establishment of points of interconnection.

15.2.2 Scheduling of deliveries.

15.2.3 Billing procedures.

15.2.4 Calculation and accounting for losses.

ARTICLE 16

APPROVAL OF REGULATORY AGENCIES

16.1 The parties hereto who may be required to do so agree that following the execution of this contract they will promptly prepare and file with all regulatory agencies having jurisdiction in the premises an application for any requisite authority to perform the obligations herein provided for. This contract shall be ineffective as to any such non-Federal Party who fails to obtain the necessary approval or acceptance by regulatory agencies having jurisdiction with respect thereto.

ARTICLE 17

GENERAL POWER CONTRACT PROVISIONS

17.1 The General Power Contract Provisions effective April 27, 1961, with revised page 2 dated August 7, 1968, and revised page 3 dated January 2, 1969, attached hereto are hereby made a part of this contract; provided, however, that Provisions B, C, D, F, G, H, I, J, K, L, M, N, Q, Y, Z and AA through FF, shall not apply to this contract, and provided that, as to Provision P, since Title 42 U.S.C. 2000 e-2(i) provides for the giving of preference to Indians in employment on or near an Indian Reservation, the obligations of the non-Federal Parties under Provision P shall be subject to any obligation undertaken by a non-Federal Party to give preference to Indians for employment for work on or near an Indian Reservation.

IN WITNESS WHEREOF, the parties hereto have caused this Power Coordination Contract to be executed as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

ARIZONA PUBLIC SERVICE COMPANY

ATTEST:

/s/ Wm. T. Quinsler
Secretary
(SEAL)

By /s/ M. C. Titus
Vice President

SAN DIEGO GAS & ELECTRIC COMPANY

ATTEST:

/s/ C. Hayden Ames
Assistant Secretary
(SEAL)

By /s/ W. A. Zitlau
Executive Vice President

SOUTHERN CALIFORNIA EDISON COMPANY

ATTEST:

/s/ J. C. Bobek
Assistant Secretary
(SEAL)

By /s/ J. K. Horton
Chairman of the Board

APPENDIX I-11

Master List
of
Permits, Authorizations and Agreements

POWER GENERATING STATION
(Communication Sites &
Limestone Quarry)

KAIPAROWITS GENERATING STATION
MASTER LIST OF
PERMITS, AUTHORIZATIONS AND AGREEMENTS

July 21, 1975
Revision 5

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	FILING DATE ACTUAL	ISSUE DATE SCHEDULED	ISSUE DATE ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
FEDERAL										
1. Environmental Protection Agency										
A. National Pollutant Discharge Elim. System Permit (NPDES)	Environmental Control Engrg./T. Bretz	TBD (See Comments)		TBD			Start of Construction (Plant)	2	6	Any intake system facility with waste discharges into the surface waters of the State (may not be required-new regulations pending).
B. Approval to Construct (Units, tanks and batch plant)	Environmental Control Engrg./K. Rosenthal	3/76		6/76			Start of Construction (Plant)	1	3	Any facility with air contaminant discharges to the atmosphere where local programs are not approved.
C. Parking Management Plan Approval	Environmental Control Engrg./K. Rosenthal	3/76		6/76			Start of Construction (Plant)	1	3	Any new facility with more than 50 parking spaces (depends on final requirements of Utah State Implementation Plan).
D. Discharge Permit (Temp. Const. Water Pipeline)	Environmental Control Engrg./T. Bretz	8/75		2/76			Start of Construction (Temp. Constr. Water Pipeline)	1	6	Any intake system facility with waste discharges into the surface waters of the State
2. Federal Communication Commission										
A. Plant Site	Communication Div./ W. G. Hupp						Plant Site Determination			Any facility with VHF paging equipment, micro wave radio to provide transmission line protection circuits, load frequency control with power system, other operating and administrative services.
1. Microwave		3/76		6/76						
2. UHF		3/76		6/76						
3. VHF		TBD		TBD						
B. Off Site Locations	Communication Div./ W. G. Hupp						Start of Construction (Individual Facility)			
1. Microwave (Fourmile Repeater Station)		3/76		6/76						
2. Microwave (Nipple Bench Repeater)		3/76		6/76					3-6	
3. Microwave (Navajo Gen. Station)		3/76		6/76					3-6	
4. VHF (Temp. Const. Water Pipeline)		9/75		1/76					3-6	

N/A - Not Applicable
TBD - To be determined

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	FILING DATE ACTUAL	ISSUE DATE SCHEDULED	ISSUE DATE ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
3. Department of the Interior										
A. Bureau of Land Management										
1. Special Land Use Permit - Preliminary Land Survey	R/W & Land Dept/ K. M. Ray (Wells)	1/74	1/74	3/74	3/74		Start of Studies Program	1/2	3	All facilities and activities on or crossing BLM lands.
2. Special Land Use Permit - Geotechnical (Phase 1)	R/W & Land Dept/ K. M. Ray (Wells)	12/73	12/73	3/74	5/74		Start of Studies Program	1/2	3	
3. Special Land Use Permit	R/W & Land Dept/ K. M. Ray (Wells)						Start of Studies Program	1/2	3	
a. Geotechnical (Phase 2)		3/75	3/75	6/75	6/75					
b. Ripping and Drilling		3/75	3/75	6/75	6/75					
c. Ripping and Drilling		3/75	3/75	6/75	6/75					
4. Special Material Sale - Clay Material	R/W & Land Dept/ K.M. Ray (Wells)	TBD (See Comments)		TBD			Start of Construction	1	18	If source is located on BLM land
5. Special Land Use Permit-Weather Station	R/W & Land Dept/ K.M. Ray (Wells)							1/2	3	
a. Nipple Bench		12/73	3/74	4/74	4/74					
b. Fourmile Bench		1/74	3/74	4/74	4/74					
6. Material Sales Use Contract - Aggregate Quarry	R/W & Land Dept/ K.M. Ray (Wells)	9/75		11/76			Start of Construction	1/2	3	
7. Special Land Use Permit-Batch Plants	R/W & Land Dept/ K.M. Ray	TBD (See Comments)		TBD			Start of Construction	1	18	If batch plants are located on BLM lands
8. Easements (Includes Access Roads)										
a. Permanent Pump Station Powerline (for 1 line)	R/W & Land Dept/ K.M. Ray (Wells)	8/75		4/76				1	7	
b. Temporary Construction Water Line and Booster Pump Stations		7/75		4/76				1	7	
c. Plant Make-up Water Lines		1/76		6/77				1	7	
d. Permanent Pumping Station(s) Boosters (Lake and Nipple Bench)		TBD		TBD				1	7	Upon completion of design
e. Construction Power - Utah Power & Light								1	11	
1. Northern Route		(See Comments)		4/76						Will be acquired by Utah Power and Light
2. Southern Route				4/76						
f. Pumping System Micro-wave										
1. Fourmile Repeater		9/75		4/76						

KAIPAROWITS GENERATING STATION
MASTER LIST OF
PERMITS, AUTHORIZATIONS AND AGREEMENTS

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	ACTUAL	ISSUE DATE SCHEDULED	ACTUAL	EXPIRATION DATE	KEY ITEM	ESTI DATA	LEAD TIMES APPROVAL	COMMENTS
9. Plant Site Acquisition	**State of Utah**	**N/A**		**N/A**			Start of Construction (Plant)	1	36	**See State Item 1-C&D**
a. Clear Oil and Gas Leases	**R/W & Land Dept/ K.M. Ray (Patterson) and Law Dept/D. Monge**	10/74	10/74	9/75			Site Acquisition			Leases not cleared by 9/75 to be condemned pending Law Dept approval.
B. National Park Service										
1. Special Land Use Permit (Includes Access Roads)	**R/W & Land Dept/ K.M. Ray**						Start of Construction (Individual Facility)	6	36	**All facilities and activities on or crossing National Park Service Lands.**
a. Temporary Construction Intake Pump and Booster Stations		7/75		4/76				1	7	
b. Temporary Construction Water Pipeline		7/75		4/76				1	7	
c. Temporary Overhead Power Line (To Northern Intake)		7/75		4/76				1	7	
2. Easements (Includes Access Roads)	R/W & Land Dept/ K.M. Ray (Wells)									
a. Permanent Intake & Booster Pump Stations (Lake and Nipple Bench)		1/76		6/77				3	18	
b. Permanent Pump Station Power Line (1 line)		1/76		6/77				3	18	
c. Permanent Make-up Water Pipeline		1/76		6/77				3	18	
3. a. Land Use Permit-Soil & Geol. Investigations. (Phase 1)	R/W & Land Dept/ K.M. Ray (Wells)	1/74	1/74	2/74	2/74		Prior to Commencement to work.	1	1	
b. Land Use Permit - Soil and Geol. Investigations (Phase 2)		TBD (See Comments)		TBD						Pending receipt of data from EDO.
C. Bureau of Reclamation										
1. Land Use Permit-Sewage Disposal Facilities	R/W & Land Dept/ K.M. Ray (Wells) and Env. Cont. Engrg/ T. G. Bretz	TBD		TBD			Start of Construction (Plant)	6	36	All facilities and activities under jurisdiction of Bureau of Reclamation.
D. Bureau of Outdoor Recreation										
1. Administrative Review	R/W & Land Dept/ K.M. Ray (Wells)	TBD		TBD						
E. Bureau of Sport Fisheries and Wild Life							Start of Construction	N/A	N/A	Part of Federal, State and Regional Review. All facilities requiring filing with EPA.
1. Administrative Review	Environmental Control Engrg/T. Bretz R/W & Land Dept/ K.M. Ray (Wells)	TBD		TBD						

KAIPAROWITS GENERATING STATION
MASTER LIST OF
PERMITS, AUTHORIZATIONS AND AGREEMENTS

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE		ISSUE DATE		EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL					
4. Department of Transportation										
A. Federal Aviation Administration										
1. **Air Navigation Approval**	Customer Service Dept/ G. W. Weist (Sparks)	10/76		2/77			Start of Construction (Plant)	1	4	Must file on all obstructions (stacks, units, etc.) in excess of 200' above ground level. No filing until final design is complete.
2. **Heliport Approval**	Customer Service Dept/ G. W. Weist (Sparks)	10/76		2/77			Start of Construction (Heliport)	1	4	
3. **Landing Strip Approval**	Customer Service Dept/ G. W. Weist (Sparks)	10/76		2/77			Start of Construction (Landing Strip)	1	4	
5. Department of Agriculture										
A. **U.S. Forest Service**										
1. **Limestone Quarry**	R/W & Land Dept/ K.M. Ray (Wells)	TBD (See Comments)		TBD			Start of Construction	12	36	If Limestone Quarry is located on U.S. Forest Service Land.
6. Department of Labor										
A. Occupational Safety and Health Administration										
1. OSHA Requirements (variance only)	Job and Safety Division/ C. E. Story	N/A		5/75-Continual			Start of Construction		Up to 1 year for approval of variance.	Adherence required for for all facilities. Adherence, review and/or variances as necessary.
7. Army Corps of Engineers										
A. Permit to Construct in Navigable Waters (Temporary)	R/W & Land Dept/ K.M. Ray (Wells) and Env. Cont. Engrg/ T. G. Bretz	8/75		4/76			Start of Construction	1	24	Construction of water intake structure in Lake Powell
B. Permit to Construct in Navigable Waters (Permanent)	R/W & Land Dept/ K.M. Ray (Wells) and Env. Cont. Engrg/ T. G. Bretz	1/77		1/79						
8. U.S. Coast Guard										
A. Aids to Navigation Agreement (Temporary)	R/W & Land Dept/ K.M. Ray (Wells)	5/76		8/76			Start of Construction	1	2	Facilities with Army Corps of Engineers requirements. Filing is subsequent to Army Corp. of Engineer approval.
B. Aids to Navigation Agreement (Permanent)	R/W & Land Dept/ K.M. Ray (Wells)	2/79		5/79						

KAIPAROWITS GENERATING STATION
MASTER LIST OF
PERMITS, AUTHORIZATIONS AND AGREEMENTS

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE		ISSUE DATE		EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL					
STATE (Applies to State of Utah, unless noted otherwise)										
1. Dept. of Natural Resources-Division of State Lands							Start of Construction	4	11	Facilities that require construction, maintenance or repairs on or across state lands. Could include temporary construction water supply.
A. Permits										
1. Special Land Use-Weather Station (Nipple Bench, Fourmile Bench) and Upgrading existing Air Strip	R/W & Land Dept/ K.M. Ray (Wells)	1/74	1/74	1/74	1/74					
B. Easements										
1. Site-Soils and Geological Studies	R/W & Land Dept/ K.M. Ray (Wells)	12/73	12/73	1/74	1/74		Prior to Commencing Studies	1	1-3	Soils and Geological Studies.
2. Construction Water Pipeline (Temporary)	R.W. & Land Dept/ K.M. Ray (Wells)	7/75		4/76				2	5	
3. Plant Make-up Water Pipeline	R/W & Land Dept/ K.M. Ray (Wells)	7/75		4/76				2	5	
4. Permanent Pump Station Power Line (for 1 line)	R/W & Land Dept/ K.M. Ray (Wells)	7/75		4/76				2	5	
5. Booster Pump Station	R/W & Land Dept/ K.M. Ray (Wells)	7/75		4/76				2	5	
6. Pumping Station Microwave	R/W & Land Dept/ K. M. Ray (Wells)									
a. Nipple Repeater		9/75		4/76						
7. Construction Power Line	R. W. & Land Dept/ K. M. Ray (Wells)									
a. Northern Route		(See Comments)		4/76				2	5	If located on state lands.
b. Southern Route				4/76						Acquisition by Utah Light and Power
8. Aggregate Quarry Access Road	R/W & Land Dept/ K. M. Ray (Wells)	11/75		11/76				2	7	
NOTE: Items 1 - 7 include Access Roads										
C. Application for Selection	R/W & Land Dept/ K.M. Ray (Wells)	3/74	4/74	5/76				3	18	
1. Amendment		12/74	12/74	5/76				3	18	
D. Agreements to Purchase Selected Lands	R/W & Land Dept/ K.M. Ray (Wells)	3/74	4/74	5/76				3	18	
1. Amendment		12/74	12/74	5/76				3	18	
2. State Water Pollution Committee										
A. Certificate of Compliance	Environmental Control Engrg/T. Bretz	TBD		TBD			Start of Construction	4	14	

KAIPAROWITS GENERATING STATION
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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	FILING DATE ACTUAL	ISSUE DATE SCHEDULED	ISSUE DATE ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
3. State Division of Highways										
A. Encroachment Permit	R/W & Land Dept/ K.M. Ray (Brooks)						Start of Construction	2	4	Facilities that require construction, maintenance or repairs on or across state Highways (i.e., highway relocations, addition of signals, change in drainage, etc.)
1. Pipeline		11/75		4/76						
B. Hauling, Over Sized-Over Weight, Off Load Site Transport	Generation Construction Div/P. Clarke Transportation/	TBD		TBD						
4. State of Utah-Dept. of Social Service-Div. of Health										
A. Approval to Construct	Environmental Control Engrg/T. Bretz	1/75	5/74	5/74	11/74		Start of Construction (Plant)	1	3	Review of final drawings, but no formal approval issued
B. Approval to Construct (Construction Phase)										
1. Waste Water Disposal System		TBD		TBD						
2. Sewage Treatment Systems		TBD		TBD						
3. Water Supply Systems		10/75		4/76						
4. Sanitary Land Fill		10/75		4/76						
C. Approval to Construct (Operational Phase)										
1. Waste Water Disposal System		TBD		TBD						
2. Sewage Treatment Systems		TBD		TBD						
3. Water Supply Systems		TBD		TBD						
B. Approval to Construct Potential Source of Air Pollution (Units, Tanks, Batch Plant). (If SCE is involved with new town, application as indirect source may be required.)	Environmental Control Engrg/K. Rosenthal	1/75	3/74	5/75	11/74		Start of Construction (Plant)	1	6	Each facility which may become a source of air pollution requires final approval
C. Camp Health Permits	Generation Construction Div/P. Clarke	TBD		TBD			Start of Construction	1	3	
5. Utah State Engineer										
A. Annual Report of Status	Development Engrg/ J. W. Kahle			12/72-83	12/72			Annual Report		
B. Request for Extension of Time (Water Appropriation)	Development Engrg/ J. W. Kahle	6/75	7/75	11/75			Expiration Date	2	3	Existing appropriation expires 11/75
C. Certificate of Dam Approval	Engineering Design/ R.W & Land Dept/ K.M. Ray	8/79		3/80			30 days prior to start of Construction (Dam)	1	3	Section 73-5-5 of Utah Code Annotated requires that plans for any Dam that will impound more than 20 acre-feet of water shall be submitted to the State Engineer for approval 30 days prior to construction.

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D. Request for Approval to relocate Stream Channel	Engineering Design/ and Env. Cont. Engrg/ T. G. Bretz	9/75		3/76				1	3	Section 73-3-29 of Utah Code Annotated requires written approval of the State Engineer to relocate any natural stream channel.
6. State Department of Fish and Game (Utah, Nevada, Arizona, and California										
A. Administrative Review of Requisitions and Procedures having Potential Impact.	Environmental Control Engrg./T. Bretz	N/A		N/A			Start of Construction	Part of Federal State and Regional Review		All facilities which require filing with the E.P.A.
7. State of Utah Public Service Commission										
A. Certificate of Convenience and Necessity	Law Dept/D. G. Monge	TBD		TBD						Will be required if Utah entity acquires unsubscribed portion
1. Plant Facilities										
8. State Department of Aeronautics										
A. Heliport Approval	Customer Service Dept/ G. W. Weist (Sparks)	10/76		2/77			Start of Construction (Heliport)	1	4	Required for all sites where plans include installation of a temporary Heliport or landing strip.
B. Landing Strip Approval	Customer Service Dept/ G. W. Weist (Sparks)	10/76		2/77			Start of Construction (Landing Strip)	1	4	Section 2-1-16 of Utah Code Annotated applies.
9. Utah Industrial Commission (Safety)										
A. Permit to Operate Equipment (Pressure Vessels)	Insurance/W. G. Hughes	7/76		9/76			Start of equipment operation	1	5	All facilities with certain types of equipment such as boilers, pressure vessels, etc.
B. Misc. Industrial Safety Permits	Insurance/W. G. Hughes	8/75		1/76			Start of Construction	1	5	
10. Environmental Coordination Comm.-State of Utah		Continuing		N/A			Completion of Environmental Report			
A. Review Environmental Report	Project Office									
Recommendations to Governor										
11. State of Arizona-Arizona Corp. Committee-Power Plant and Transmission Line Siting Committee										
A. Annual Ten-Year Plan	Law Dept/D. Monge	N/A		1/74-83	1/74					Annual Report

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12. Utah State Fire Marshal										
A. Fire Protection Review and Approval	PMO/W. F. Long						Start of Construction (Plant)	1	5	Whenever a Building Permit is required. All fire protection drawings and calculations finalized by filing date.
1. Booster Sta. Bldg.		2/76		4/76						
LOCAL										
1. Kane County Sheriff Dept.										
A. Burning Permit (Brush)	PMO/W.F.Long						Start of Construction	1	2	Required to burn excess debris from site.
1. Access Roads		9/75		11/75						
2. Retention Basin		3/76		5/76						
3. Site Preparation		6/76		8/76						
4. Quarry Access Road		8/76		10/76						
5. Temp. Const. Water Pipeline		3/76		4/76						
2. Kane County Dept. of Bldg. & Safety										
A. Grading Permit	PMO/W.F.Long	1/76		4/76			Start of Construction	1	6	Required by the 1973 Uniform Building Code. All grading drawings, calculations and soils report required by filing date.
B. Electrical Permits (Front End, if required)	PMO/W.F.Long									
1. Temp. Const. Power		2/76		4/76						
C. Building Permits (Front End Permits, if required)	PMO/W.F.Long						Start of Construction	1	6	Required by the 1973 Uniform Building Code. All construction drawings and calculations required by filing date of each individual building permit
1. Project Site Substation		12/75		3/76						
2. Source Site Substation		12/75		3/76						
3. Retention Basin		1/76		4/76						
4. Diesel Generator Foundation		12/75		3/76						
5. Water Pump Foundations		9/75		1/76						
3. Kane County Planning Commission										
A. Zoning Change	Law Dept/ D.G. Monge	7/75	6/75	11/75		As Amended	Start of Construction	1	7	Required for Rezoning Project Site.
4. Kane County Road Dept.										
A. Overload Approvals	Traffic Dept/	TBD		TBD			Start of Construction	1	2	Required for transportation of excessive loads over county roads.
B. Construction Permit	PMO/W.F. Long						Start of Construction	1	5	Required for construction of county roads. All construction drawings & calculations required by filing date.
1. Initial Entry Road - Utah State Highways		7/75		11/75						
2. Quarry Access Road - SCE		6/76		10/76						
3. Main Access Road - Utah State Highways		7/75		11/75						
4. Access and Patrol Roads - Temp. Const. Water Pipeline		11/75		4/76						

MINING FACILITIES

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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE		ISSUE DATE		EXPIRATION DATE	KEY ITEM	ESTIMATED LEAD TIMES		COMMENTS
		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL			DATA PREP	APPROVAL	
FEDERAL										
1. Environmental Protection Agency										
A. National Pollutant Discharge Elim. System Permit (NPDES)							Start of Construction	2	6	Any intake system facility with waste discharges into the surface waters of the State (may not be required - new regulations pending).
B. Approval to Construct							Start of Construction	1	3	Any facility with air contaminent discharges to the atmosphere where local programs are not approved.
C. Parking Management Plan Approval							Start of Construction	1	3	Any new facility with more than 50 parking spaces (depends on final requirements of Utah State State Implementation Plan).
2. Federal Communication Commission										
A. Micro-Wave Protection							Start of Construction	9	4	Any facility with VHF paging equipment, microwave radio.
B. Mine Radio System								5	7	
3. Department of the Interior										
A. Bureau of Land Management										
1. Special Land Use Permits - General								1/2	3	All facilities and activities on or crossing BLM lands.
2. Special Land Use Permit - Drilling Program								1/2	3	Drilling sites approved individually or in groups.
3. Special Material Sale - Clay Material							Start of Construction	1	18	If source is located on BLM land
4. Special Land Use Permit - Weather Station								1/2	3	
5. Material Sales Use Contract - Aggregate Quarry							Start of Construction	1/2	3	
6. Material Sales Use Contract - Limestone Quarry										If source is located on BLM land
7. Special Land Use Permit-Batch Plants							Start of Construction	1	18	If batch plants are located on BLM lands

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8. Easements (Includes Access Roads)										
a. Temporary Construction Water Line and Booster Pump Stations								1	7	
b. Make-up Water Lines								1	7	
c. Construction Power Utah Power & Light								1	11	
9. Site Acquisition							Start of Construction	1	36	
a. Clear Oil and Gas Leases -							Site Acquisition			
B. Bureau of Mines										
1. Mining Enforcement & Safety Administration (MESA)										
a. Mine Identification										
b. Roof Control Plan										
c. Ventilation Plan										
d. Evacuation Plan										
e. Fire Drill Plan										
C. Geological Survey										
1. Mining Plan										Mining Plan is reviewed and approved in conjunction with BLM & Bureau of Mines; USGS is the authorized agency.
D. Bureau of Reclamation										
1. Land Use Permit - Sewage Disposal Facilities							Start of Construction	6	36	All facilities and activities under jurisdiction of Bureau of Reclamation
E. Bureau of Outdoor Recreation										
1. Administrative Review										
F. Bureau of Sport Fisheries and Wild Life							Start of Construction	N/A	N/A	Part of Federal, State and Regional Review. All facilities requiring filing with EPA.
1. Administrative Review										

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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	FILING DATE ACTUAL	ISSUE DATE SCHEDULED	ISSUE DATE ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
5. Department of Agriculture										
A. U. S. Forest Service										
1. Limestone Quarry							Start of Construction	12	36	If Limestone Quarry is located on U.S. Forest Service Land
6. Department of Labor										
A. Occupational Safety and Health Administration										
1. OSHA Requirements (variance only)							Start of Construction		Up to 1 year for approval of variance	Adherence required for all facilities Adherence review and/or variances as necessary.
STATE (Applies to State of Utah, unless noted otherwise)										
1. Dept. of Natural Resources-Division of State Lands										
A. Permits							Start of Construction	4	11	Facilities that require construction, maintenance or repairs on or across state lands.
B. Easements										
1. Site-Soils and Geological Studies							Prior to Commencing Studies	1	1-3	Soils and Geological Studies
2. Construction Water Pipeline								2	5	
3. Mine Water Pipeline								2	5	If located on state lands
4. Construction Power Line								2	5	
5. Aggregate Quarry Access Road								2	7	
Note: Items 1 thru 4 include Access Roads										
C. Application for Selection								3	18	
								3	18	
D. Agreements to Purchase Selected Lands								3	18	

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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE		ISSUE DATE		EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL					
2. State Water Pollution Committee										
A. Certificate of Compliance							Start of Construction	4	14	
3. State Division of Highways										
A. Encroachment Permit							Start of Construction	2	4	Facilities that require construction, maintenance or repairs on or across State Highways (i.e., highway relocations, addition of signals, change in drainage, etc.)
B. Hauling, Over sized-Over Weight, Off Load Site Transport										
4. State of Utah - Dept of Social Service - Div. of Health										
A. Approval to Construct							Start of Construction	1	3	Review of final drawings, but no formal approval issued.
1. Waste Water Disposal System										
2. Sewage Treatment Systems										
3. Water Supply Systems										
B. Approval to Construct Potential Source of Air Pollution							Start of Construction	1	6	Each facility which may become a source of air pollution requires final approval.
C. Camp Health Permits							Start of Construction	1	3	
5. Utah State Engineer										
A. Annual Report of Status								Annual Report		
B. Certificate of Dam Approval							30 days prior to start of Construction (Dam)	1	3	Section 73-5-5 of Utah Code Annotated requires that plans for any Dam that will impound more than 20 acre-feet of water shall be submitted to the State Engineer for approval 30 days prior to construction.

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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	FILING DATE ACTUAL	ISSUE DATE SCHEDULED	ISSUE DATE ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
C. Request for Approval to relocate Stream Channel								1	3	Section 73-3-29 of Utah Code Annotated requires written approval of the State Engineer to relocate any natural stream channel
D. Application to appropriate Underground Water (#44449 (89-1154)			12/74							Underground water application for exploratory drilling. (Garkane Power Assn. has prior filing in same area)
E. Application to appropriate Water			12/74							Underground water application for coal washing and other related purposes.
6. State Department of Fish and Game (Utah, Nevada, Arizona, and California)										
A. Administrative Review of Requisitions and Procedures having Potential Impact							Start of Construction	Part of Federal, State & Regional Review		All facilities which require filing with the E.P.A.
8. State Industrial Commission							Start of Employment			Advise that operations are planned. Acquire employer ID No. and set up workman's compensation.
A. Safety Division										
1. Permit to operate Equipment							Start of Equipment Operation	1	5	All facilities with certain types of equipment such as boilers, pressure vessels, etc.
2. Misc. Industrial Safety Permits							Start of Construction	1	5	
9. Enviornmental Coordination Comm. - State of Utah							Completion of Environmental Report			
A. Review Environmental Report										
B. Recommendations to Governor										
10. Utah State Fire Marshall										
A. Fire Protection Review and Approval.							Start of Construction	1	5	Whenever a Building Permit is required. All fire protection drawings and calculations finalized by filing date.

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		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL					
LOCAL										
1. Kane County Sheriff Dept.										
A. Burning Permit (Brush)							Start of Construction	1	2	Required to burn excess debris from site.
2. Kane County Dept. of Building & Safety										
A. Grading Permit							Start of Construction	1	6	Required by the 1973 Uniform Building Code All grading drawings, calculations and soils report required by filing date
B. Electrical Permits										
C. Building Permits							Start of Construction	1	6	Required by the 1973 Uniform Building Code. All construction drawings and calculations required by filing date of each individual building permit.
3. Kane County Planning Commission										
A. Zoning Change							Start of Construction	1	7	Required for Rezoning Project Site
4. Kane County Road Dept.										
A. Overload Approvals							Start of Construction	1	2	Required for transportation of excessive loads over county roads.
B. Construction Permit							Start of Construction	1	5	Required for construction of county roads. All construction drawings & calculations required by filing date.

NEW TOWN

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AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT/ ASSIGNED COORDINATOR	FILING DATE SCHEDULED	ACTUAL	ISSUE DATE SCHEDULED	ACTUAL	EXPIRATION DATE	KEY ITEM	ESTIMATED DATA PREP	LEAD TIMES APPROVAL	COMMENTS
FEDERAL										
1. Environmental Protection Agency										
A. Approval to Construct Water Treatment and Sewage Disposal Fac.	KAISER INDUSTRIES Nash/Richards						Start of Construction New Town			
2. Dept. of Interior - Bureau of Land Mgt.										
A. Special Land Use Permits for:	KAISER INDUSTRIES Nash/Richards						After Site Selection			
(1) Preliminary Geological Investigations	" "						"			
(2) Land Surveys	" "						"			
(3) Preliminary Work on Foundation for Water & Sewer Plants	" "						"			
(4) Access Roads	" "						"			
(5) Construction of Water Line from Lake Powell or	" "									
(6) Construction of Water Wells	" "									
(7) Construction Camp	" "									
B. Clear Existing Impediments										Prior to Land Transfer
(1) Clear Grazing Leases	" "									
(2) Clear Oil & Gas Leases	" "									
C. Dispose of Land to State of Utah										
(1) Receive "No Adverse Use Report from State	KAISER INDUSTRIES Nash/Richards									State Land Board Issues Report
3. Dept. of Agriculture										
A. Farmers Home Adm.										
(1) Eligibility Designation for Housing Assistance	" "									
(2) Assistance for Water & Sewer Grants	" "									
4. Environmental Protection Agency										
A. Sewer & Water Grants	" "									

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5. Dept. of Transportation										
A. Agreement to Assist in Funding Collector Roads	" "									Roads Constructed by the Company Not State Highway Dept.
B. Agreement for Airport Assistance Funds	" "									
(1) Apply for Inclusion in National Airport System Plan	" "									
(2) Apply for Air Space Clearance anf FAA Endorcement	" "									
(3) Public Hearing FAA Approval & Application for 90% Funding	" "									
6. Dept. Hsg. & Urban Dev										
A. Agreement for 701 Planning Assistance	KAISER INDUSTRIES Nash/Richards									
B. F.H.A. Insurance on New Town Houses	" "									
C. Agreement for Community Development Grants (Block Grants)	" "									
D. Agreement for Title X Insurance on Development Bonds	" "									
STATE OF UTAH										
1. State School Dept.										
A. Agreements for School Assistance	" "									Under SB 256 - 1975 Legislature
2. State Land Board										
A. Agreement to Purchase Land	" "									
B. Easements on State Sections	" "									
3. Governor Planning & Development Advisory Board	" "									Applies to Fourmile Bench
A. General Concurrence with Town Plan	" "									
4. Health Dept.										
A. Sanitary Sewer System	KAISER INDUSTRIES Nash/Richards									
B. Domestic Water System	" "									
Solid Waste Disposal System	" "									

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		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL					
KANE COUNTY										
1. Rezoning Application										
2. Planned Unit Development Application										
3. Conditional Use Permits										
4. Preliminary Plat Approvals										As Required
5. Final Plat Approvals										
6. Construction Plan Approvals										
7. Building Permits										

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TRANSMISSION SYSTEM

AGENCY/DESCRIPTION	RESPONSIBLE DEPARTMENT ASSIGNED COORDINATOR	FILING DATE		ISSUE DATE		EXPIRATION DATE	KEY ITEM	ESTIMATED LEAD TIMES		COMMENTS
		SCHEDULED	ACTUAL	SCHEDULED	ACTUAL			DATA PREP	APPROVAL	
Eldorado-Kaiparowits Nos. 1 & 2 500 kV T/L	T/S Engrg/Romero									
1. Department of the Interior										
A. Bureau of Land Management	R/W & Land Dept/ K.M. Ray (Wells)	10/76		10/79			Start of Construction (T/L)			
1. T/L Easements										
B. Bureau of Indian Affairs	R/W & Land Dept/ K.M.Ray (Wells)	10/76		10/79			Start of Construction (T/L			Kaibab Indian Reservation
1. T/L Easements										
2. Department of Transportation										
A. Federal Aviation Administration	Customer Service Dept/ G.W.Weist (Sparks)	3/77		3/78			Start of Construction (T/L)	1	4	File when plans are firm and final.
1. Air Navigation Approval										
3. State of Arizona-Arizona Corp. Committee-Transmission Line Siting Committee	Environmental Planning/G.L.Dudley	2/76*		9/76*			Start of Construction (T/L)			*Being investigated with APS.
4. County Planning Commissions	Customer Service Dept/ L.G. Prutsos (Sparks)						Start of Construction (T/L)			
A. Conditional Use Permits										
1. Kane County, Utah		6/77		1/78						
2. Washington County, Utah		6/77		1/78						
3. Lincoln County, Nevada		6/77		1/78						
4. Clark County, Nevada		6/77		1/78						
5. Mohave County, Arizona		6/77		1/78						
6. Coconino County, Arizona		6/77		1/78						
Eldorado - Mohave No. 2 500 kV T/L	T/S Engrg/McCreight									
1. Department of the Interior										
A. Bureau of Land Management	R/W & Land Dept/ K.M.Ray (Wells)	10/76		10/79			Start of Construction (T/L)			
1. T/L Easements										
2. Department of Transportation										
A. Federal Aviation Administration	Customer Service Dept/ G.W. Weist	3/77		3/78			Start of Construction (T/L)	1	4	File when plans are firm and final.
1. Air Navigation Approval										
3. State of Arizona-Arizona Corp. Committee-Transmission Line Siting Committee	Environmental Planning/G.C. Dudley	2/76*		9/76*			Start of Construction (T/L)			*Being investigated with APS.
4. County Planning Commissions	Customer Service Dept/ L. G. Prutsos						Start of Construction (T/L)			
A. Conditional Use Permits										
1. Clark County, Nevada		8/78		2/79						

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Devers-Mohave Nos. 1 & 2 500 kV T/L's	T/S Engrg/Patterson									
1. Department of the Interior										
A. Bureau of Land Management	R/W & Land Dept/ K.M. Ray (Wells)	2/76		11/78			Start of Construction (T/L)			
1. T/L Easements										
B. Bureau of Indian Affairs	R/W & Land Dept/ K.M. Ray (Wells)	2/76		11/78						Agua Caliente Indian Reservation
2. Department of Transportation										
A. Federal Aviation Administration	Customer Service Dept/ G.W. Weist (Sparks)	2/76		7/76			Start of Construction (T/L)	1	4	File when plans are firm and final.
3. State of California-Public Utilities Commission	Law Dept/ D. Monge									
A. Certificate of Convenience and Necessity		11/75		11/76			Material Commitment			
4. County Planning Commission										
A. Conditional Use Permits	Customer Service Dept/ L.G. Prutsos (Sparks)	10/77		4/78			Start of Construction (T/L)			
1. Clark County, Nevada										
Devers-Serrano Nos. 1 & 2 500 kV T/L'S	T/S Engrg/Lui									
1. Department of the Interior	R/W & Land Dept/ K.M.Ray (Wells)						Start of Construction (T/L)			
A. Bureau of Land Management										
1. T/L Easements		3/76		1/79						
B. Bureau of Indian Affairs	R/W & Land Dept/ K.M.Ray (Wells)	4/69	4/69	1/79			Start of Construction (T/L)			Morongo Indian Reservation
1. T/L Easements										
2. Department of Agriculture	R/W & Land Dept/ K.M.Ray (Wells)									
A. U.S. Forest Service							Start of Construction (T/L)			Cleveland National Forest
1. T/L Easements		3/76		1/79						
3. Department of Transportation	Customer Service Dept/ G.W. Weist (Sparks)						Start of Construction (T/L)	1	4	File when plans are firm and final.
A. Federal Aviation Administration		2/76		7/76						
4. State of California-Public Utilities Commission	Law Dept/ D. Monge									
A. Certificate of Convenience and Necessity		11/75		11/76			Material Commitment			

APPENDIX I- 12

State of Utah Executive Order Creating the Kaiparowits Planning and Development Advisory Council

APPENDIX I-12

STATE OF UTAH
EXECUTIVE DEPARTMENT

EXECUTIVE ORDER

WHEREAS, the introduction of new energy resource activities into Garfield and Kane Counties will have an impact of considerable magnitude on the existing pattern of development; and

WHEREAS, in anticipation of this impact, there exists a need for a coordination process to facilitate planning and decision-making between federal, state, and local governments; and the private sector concerning energy resource developments; and

WHEREAS, the local elected officials of Kane and Garfield Counties recognize the importance of providing a means by which all proposed activities having a direct influence on the future development of the area should be reviewed and taken into consideration:

NOW, THEREFORE, I, Calvin L. Rampton, Governor of the State of Utah, by virtue of the authority vested in me by the Constitution and Laws of the State of Utah, do hereby order as follows:

There is hereby created a Kaiparowits Planning and Development Advisory Council to guide and coordinate activities related to energy development in Kane and Garfield Counties.

I. **The purposes of the Council are:**

   A. Function as a local clearinghouse for energy planning and development activities underway or proposed for Kane and Garfield Counties.

   B. Develop and provide state and county local input to the Environmental Impact Statement being developed by the Federal Department of Interior - Bureau of Land Management.

   C. Through participating governmental and private agencies, identify and/or secure funding and other resources to assist in planning and development efforts related to the Kaiparowits or other energy projects in the two counties, as needed.

   D. Direct and/or carry out specific energy related planning or development activities, as requested by the counties or other participating governmental units or agencies.

   E. Function as the liaison and communication body between the private development corporations, community and federal, state, and local agencies directly related to the Kaiparowits and other energy projects in Kane and Garfield Counties.

   F. Implement a process whereby community input may be received and reviewed by the Council and a continuing public education program is carried out.

   G. Coordinate Kaiparowits and other energy construction and development planning with county planning and municipal development so as to attempt to prevent an influx of workers and related population to areas where there are not adequate and attractive housing and related facilities.

II. To fulfill the purposes of this Order, any agency of local, state, or federal government, any state or private university, or private developer initiating studies, plans, or specific development proposals, affecting the utilization of energy resources shall first submit such studies, plans, or development proposals to the Council for their review and recommendations to insure optimum coordination of energy resource development.

The Council shall consist of twenty-seven (27) representatives as follows:

Merrill R. MacDonald, Kane County Commissioner
James M. Yardley, Garfield County Commissioner
Dixie Leavitt, Utah State Senator
S. Garth Jones, Utah State Representative
Fred B. Harris, Beaver County Commissioner
    Representing Five-County Association
    of Governments

William G. Bruhn, Executive Director
    Department of Community Affairs
Burton L. Carlson, State Planning Coordinator
Clem Church, State Road Commission
Gordon M. Harmston, Executive Director
    Department of Natural Resources
Herbert J. Allen, Manager, Department
    of Employment Security, Panguitch
Milton L. Weilenmann, Executive Director
    Department of Development Services
Paul S. Rose, Executive Director
    Department of Social Services
Blaine Kay, Director, Department of Highways
Morgan S. Jensen, District Manager
    Bureau of Land Management, Kanab
Earle B. Curran, Superintendent, Cedar
    Breaks National Monument
    National Park Service
Walter W. Pierson, District Forest Ranger
    Dixie National Forest, Forest Service

Dale Marsh, Garfield County Commissioner
Sterling Griffiths, Kane County Commissioner
Vernon Barney, Garfield County School District
Doyle Swallow, Kane County School District
Dr. Wallace G. Lee, Mayor of Panguitch
Claude M. Glazier, Mayor of Kanab
George Rampton, Dixie College
Dr. McRay Cloward, Southern Utah State College
James Carrico, Citizen's Advisory Committee
    Kane County
Robert S. Currie, Project Manager
    Southern California Edison Company
Elton H. Buell, Vice President,
    Resource Company, Arizona

The first five members above designated shall constitute an Executive Committee with the authority to act between meetings of the full Council. The Executive Committee shall designate from its members an individual who shall serve as chairman of both the Council and the Executive Committee.

The initial appointees to the Council, or their successors, shall serve until such time as the Council is dissolved by the Governor.

Staff support to serve the Council shall be provided by state government agencies and the Five County Association of Governments as required.

IN WITNESS WHEREOF, I have set my hand and caused to be affixed the Great Seal of the State of Utah. Done at the State Capitol in Salt Lake City, Utah, this 7th day of August, 1974.

Calvin L. Rampton
Governor

By the Governor
Clyde L Miller
Secretary of State
By Euela C. McCay
Assistant Deputy

APPENDIX I- 13

Kaiparowits Access Road Study, Kaiparowits Planning and Development Council

APPENDIX I-13

five county association of governments

POST OFFICE BOX 261
CEDAR CITY, UTAH 84720
PHONE 586-4842, 586-9986

November 21, 1974

Mr. Frank Snell
EIS Core Team
Federal Building Annex
135 South State Street
Salt Lake City, Utah 84111

Dear Mr. Snell,

For some weeks the Kaiparowits Planning and Development Council, through its Access - Highways Work Group, has been studying and developing alternatives for an access system related to the Kaiparowits Power Project. The Work Group submitted its formal recommendations to the Planning and Development Council for consideration and approval on November 18.

The Planning and Development Council and Executive Committee approved the recommendations of the Work Group on November 18. We now formally submit the following basic action proposal and alternatives for access - highways development to the B.L.M. for input into the Environmental Impact Statement.

It is the basic action proposal of the Planning and Development Council that:

1. The Access - highways system planned and constructed to support the Kaiparowits Power Project and proposed New Community should be a 'through system' from Cannonville in Garfield County (on the North) to the Glen Canyon City (East Clark Bench - New Community Site) on the South - U.S. 89.
2. The 'through' access system for the Fourmile Bench Plant site should include road segments B.1, B.6, and B. 10. (See page 16 - attached materials)
3. The 'through' access system for the Nipple Bench Plant site should include road segments B.1, B.6, B.10, and C. 1. (See Page 16 - attached materials)
4. This 'through' access system will serve either the New Community site at East Clark Bench (action proposal) or Butler Valley (alternative).

In the attached materials four 'access road alternatives' are described and defined, one of which is the one approved as the Council's action proposal. We submit the other three access road alternatives (Pages 15, 17, 18) as alternatives to the basic action proposal B.1, B.6, B.10, and C.1 system for purposes of the Environmental Impact Statement.

BEAVER GARFIELD IRON KANE WASHINGTON

Based on our previous discussion with EIS Core Team members, we trust that this report of action taken by the Council and the submittal of the attached material will meet the access - highways information needs for the EIS. If further information of clarification of action is needed, please contact the Council as soon as possible.

We have greatly appreciated the cooperation of the EIS Core Team in our efforts to develop the access - highways action proposal and alternatives, and shall look forward to that same cooperation in the future.

Sincerely,

Merrill R. MacDonald
Chairman

cc: Morgan Jensen
James Biggins

KAIPAROWITS POWER PLANT ACCESS ROAD
LOCATION AND FEASIBILITY STUDY
NOVEMBER 15, 1974

A. General

This Study can be broken into three basic units: written data on the area and the alternates (Pages 1 through 8), tabular data showing comparisons between alternates (Pages 9 through 14) and area maps which display the alternates (following Page 14). The Utah State Department of Highways, under the direction of the Utah State Road Commission, is acting on behalf of Kane and Garfield Counties in the preparation of this Study. Final roadway design, construction and maintenance responsibility will be determined at a later date depending on funding source and jurisdictional responsibility. Detailed roadway design should not start until the plant site is determined or the access road alternate selected.

Based on the fact that all access road alternates outlined herein are relatively long in length and quite expensive, it may be desirable to award two or more construction projects for the selected alternate. There are advantages to this procedure as compared with awarding one construction contract for all access roads required. A single contract would be of such magnitude in scope of work and cost that many potential contractors could not, or would not, bid on the project. Two, or more, contracts could be awarded and built almost simultaneously. It is anticipated that the first contract could be awarded approximately one year after go-ahead is given for design on a final access road alternate. Each contract will probably take 12 to 18 months to complete. Prior to award of any highway construction contracts, some preliminary grading should be performed so that plant construction personnel can get their equipment to the selected plant site.

There appear to be three basic destination points which must be connected by a road network, i.e., the power plant, the coal mine and a community. This community, whether new or not, will provide the residences for the majority of the people working at the plant and coal mine. The major uses for the access roads are expected to be as follow:

1. Power Plant Access. Two power plant sites, one at Fourmile Bench and one at Nipple Bench, have been given consideration in this Study. It is expected that as many as 2,500 people will be working on the plant at the height of its construction. After completion, slightly over 500 people will be required to operate the plant. Although access roads may not adequately serve the construction force for the first year or two, they should be completed and available before the height of construction is reached.

2. Coal Mine Access. Normal mine operation is expected to require 2,100 workers who will require a good quality access facility. It is expected that these 2,100 workers will be divided into three working shifts (two operational and one maintenance).

3. Community Access. It is anticipated that over 4,000 additional jobs will be generated to provide support for the power plant plus mine employees and their families. This community will also require high quality access to and from the existing State Highway System. Due to its nearness to the Glen Canyon Recreation Area, this community will undoubtedly also serve as a hub for recreational activities by providing motels, restaurants, sales outlets for recreation equipment and other such facilities to entice visits by recreation-oriented people from all across the country. Therefore, the size of this community may consist of from 15,000 to 20,000 people. Such a community would be the largest city for hundreds of miles in any direction. One proposal specifies a new community in the Clark Bench Area (west of Glen Canyon City) while another places the town site at Butler Valley, near Grosvenor's Arch. Although other town sites have been evaluated, the above two are the only sites which seem to be receiving serious consideration at this time. It is anticipated that some employees will reside in Page, Arizona while others will reside in the Cannonville-Tropic area. However, a large majority of the employees are expected to reside in the new community.

4. Recreation Traffic. Any, or all, of the access road alternates being considered could provide access to many areas of interest to recreationists. Backpackers, sightseers, campers and water enthusiasts are some of the types of individuals who might be interested in travelling on the access road alternates under study.

5. Maintenance Road. Portions of each access road alternate may also serve as a maintenance road for such plant auxiliary items as the coal conveyor line, the water pipeline and the electrical transmission lines. Each of these different lines will require at least a low-grade maintenance road and, in those areas where the access road is in close proximity, it should be able to serve the dual function of area access and facility maintenance.

In addition to the employees working at the plant, the mine and the community itself, there will be others working for a limestone trucking operation. It has been estimated that 30 trucks per day for six days a week will be required to provide limestone for the emission control system at the power plant. The limestone quarry is located north of Bryce Canyon and the truck route is expected to pass through the Cannonville-Tropic area.

Even if the Clark Bench or Butler Valley site is selected for the new community, it is expected that approximately 5% of the plant-mine employees will still desire to live in the Cannonville-Tropic area. This desire will be predicted on the availability of adequate supporting facilities, i.e., culinary water, sewage system, utilities, schools, shopping areas, etc. By combining the employees from the trucking operation with 5% of the plant-mine employees, an estimate of 150 new families (450-500 people) may be added to the existing population in the Cannonville-Tropic area. Paragraph D. considers road user costs for the various access road alternates addressed in this Study. No attempt has been made to calculate road user costs for the Cannonville-Tropic commuters just mentioned. Their desire would undoubtedly be for the most direct route possible to their place of work. It is of interest to note that actions are now under way in Garfield County to provide the necessary support facilities for the Cannonville-Tropic area to accommodate the new community should such a course of action be in the best interest of all parties concerned.

The highest volume of traffic on each access road alternate will occur during the typical rush hours created by commuters going to and returning from work. At other times of the day, the access roads should see only limited use. An analysis of the expected traffic volumes and the design standards of the Utah Department of Highways indicate that a 34-foot wide road (two 11-foot lanes and two 6-foot shoulders) should be adequate. Paragraph D. of this Study goes into further detail on the projected traffic volumes and their use in calculating road user costs. Many of the access road alternates will involve relatively long commuting distances (over 30 miles one-way in some instances). It is, therefore, very desirable to have a roadway facility which would allow a reasonable speed (40-50 mph) so as to keep commuting time from becoming excessive. Long grades in excess of 6% should be avoided, if possible, as they drastically affect the speeds of large trucks; and they are hazardous to drive and hard to maintain in winter weather.

Even though the average annual precipitation on the benches ranges from 6 to 10 inches, flash flooding is not at all uncommon due to the types of storms, the lack of dense vegetation and the types of soils and rock formations found in the area. Accordingly, each access road alternate will require some relatively expensive hydraulic structures to prevent road damage during flash floods. The cost estimates included herein for access roads have given consideration to the local hydraulic problems.

Rivers and streams which might be traversed by one or more of the access road alternates flow little or no water during the hot, dry summer months. In addition, many of the stream beds show evidence of high alkali concentrations in the water. It is, therefore, not surprising that these drainages do not provide a fishery.

Some of the more abundant wildlife in the area include mule deer, cottontail rabbits, mourning dove, quail, mountain lion, bobcat and coyote. Due to the sparse vegetation and lack of water in the area, these species are no more abundant than one might expect in a desert. The most abundant form of animal life which greets a visitor to the area is range cattle, and even they are not in great numbers.

A problem common to this general area is the lack of sources of good quality aggregate, or gravel. Wahweap Creek and Horse Mountain (located at the north edge of Fourmile Bench) appear to be the only sources in the immediate area which can supply an aggregate which is both of good quality and sufficient quantity for major construction projects. Aggregate from Wahweap Creek was used in the construction of Glen Canyon Dam (approximately 17 miles to the southwest). Preliminary estimates of total aggregate requirements for each alternate are included in Tables I and IV on Pages 9 and 12, respectively. These estimates are based on the need for 12,000 cubic yards of aggregate per mile for use in the surfacing and as untreated base course.

Information obtained for this Study indicates the coal mine operations complex to be generally located in Sections 3 and 4 of Township 41 South, Range 3 East, Salt Lake Base and Meridian. This location would serve both the Fourmile and Nipple Bench sites.

Most canyons in the area follow a winding route and are characterized by narrow bottoms with steep to vertical side slopes (generally averaging one to one side slopes). Wahweap and Nipple Creeks are in the only canyons which really deviate from the characteristics described above. Wahweap Creek is different in that it flows in a relatively straight, wide bottomed canyon for most of its route, and Nipple Creek does not have the steep, high canyon walls that are typical in the other canyons. For this Study, an attempt was made on each alternate to hold heavy cuts and fills at a minimum and to leave the terrain in its existing condition wherever possible. All alternate locations, as indicated on the maps in this Study, are subject to minor change during detailed design. Time and appropriate mapping will then be available to allow the highway designers to set the horizontal and vertical alignments in such a way as to further minimize deep cuts, deep fills, stream encroachments and damage to any other aesthetically pleasing features.

The Tables, starting on Page 9, show the alternate access roads which would provide the required access for the plant, the mine and the community. The estimated costs included herein have taken into consideration both the heavy truck loads and inflation to date. It is entirely possible that other combinations of the segments outlined in this Study can be used to make additional alternatives, which may be as viable as those listed. There are many other canyons which could serve as alternate routes in providing access to Fourmile Bench. However, those routes which appeared most reasonable were given consideration. From the information obtained, it appears that some of the alternates evaluated and described herein are bordering on the unrealistic. Many canyons not selected for study have advantages, and disadvantages, similar to those that were selected. Even though the area is generally mountainous, its arid nature basically brings it into a desert-type category. Wildlife and plant life populations are sparse unless compared with similar desert-type situations, and then the populations would probably be classed as average. Although, when first viewed, the terrain is interesting to look upon, it does have a tendency to become monotonous to many individuals upon staying in the area for a length of time. Due to the relative vastness of the area, the access roads can be designed and constructed in such a way as to make them blend in with or be hidden by the surrounding country. Normal procedures include watering of unpaved highways during construction. This action will help minimize the negative impact created by dust for those using the highway or viewing the area from a distance.

B. Fourmile Bench Access Roads

Fourmile Bench is accessible from Cannonville by a generally well-graded dirt road. This existing route will provide adequate fair-weather access to the Fourmile Bench site for the plant construction crews and equipment. Access to the coal mine will be via narrow 4-wheel drive jeep trails until considerable leveling and widening is performed on these trails by a grader or until an adequate paved road can be constructed. It is desirable to have access to the plant site from both the north (Cannonville and State Route 12) and the south (Glen Canyon City and U.S. 89). Accordingly, all of the alternates will provide access from both directions. The segments of the access road alternates for the Fourmile Bench site are:

1. Cannonville to Fourmile Bench. This piece of existing dirt road is approximately 34.8 miles long. It passes through grasslands and cultivated fields for the majority of the distance between Cannonville and Grosvenor's Arch. The section from Grosvenor's Arch to the Fourmile Bench site passes through areas of light brush and light-to-medium concentrations of junipers. Included in this segment would be some 39 stream crossings and a maximum grade of 8% for approximately one mile of the total distance. Except for the few sections of 8% grade, the vertical alignment would traverse gently rolling terrain with all other grades being less than 6%. One of the few areas of heavy construction on this segment of highway would be through the area known as "The Gut" which is adjacent to Grosvenor's Arch. The geologic formations are steeper at this point and would require some short sections of moderate cuts and fills. Aggregate sources can be obtained from Wahweap Creek, Paria River, the hills of Round Valley and on Horse Mountain. The estimated cost for this segment is $14,500,000.

2. U.S. 89, west of Glen Canyon City to Grosvenor's Arch via Cottonwood Creek. This 28.7 mile segment begins on U.S. 89, approximately 11 miles west of Glen Canyon City. Gently rolling terrain is found throughout this segment accompanied by only light brush and light juniper cover. All vertical grades would be less than 4% and 20 stream crossings would be encountered. Most of this segment is also occupied by high power electrical lines. Aggregate sources would be available from Paria River, Horse Mountain and Wahweap Creek. The estimated cost for this segment is $9,700,000.

3. Glen Canyon City to Cannonville Road via Wahweap Creek and Tommy Smith Creek. A paved road through this route would be approximately 29.4 miles long and would be almost entirely located in, or adjacent to, existing stream beds. Although the vertical grades would be less than 2%, the section running through Tommy Smith Creek will be in a narrow, steep-sided canyon which will present hydraulic and road construction problems. The section in Wahweap Creek will be in a canyon bottom also, but one that is not as narrow as Tommy Smith Creek. Generally, the canyon carrying Wahweap Creek has a bottom wide enough for both a slightly elevated, side riprapped road and the Creek. Both canyon bottoms are sparsely vegetated with a few trees, light brush and grasses where stream banks exist. This road would contain 22 stream crossings, and all necessary aggregate would be readily available in Wahweap Creek. The estimated cost for this segment is $10,100,000.

4. Glen Canyon City to Cannonville Road via Wahweap Creek, Tommy Smith Creek and Fourmile Creek. This 28.7 mile segment would be very similar to that found in paragraph B.3. above. The Fourmile Creek Canyon is very narrow just as Tommy Smith Creek Canyon. Just over a mile and a half of 4% grade would be required in Fourmile Creek Canyon. Vegetation and aggregate sources would be generally the same as in B.3. above and would include 26 stream crossings. The estimated cost for this segment is $10,700,000.

5. Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run. A 25.2 mile road with a continuous one and one-half mile 7% grade would be required in this segment. Other than the 7% grade in Smith Run, the general terrain will allow a 4% grade or less. Smith Run Canyon is very similar to Tommy Smith Creek and Fourmile Creek Canyons. However, this road segment will require only 9 stream crossings. Wahweap Creek and Horse Mountain are again the best sources of aggregate. A short section in Nipple Creek contains an exposed shale layer which exhibits very poor road building characteristics. This shale will have to be kept as moisture free as possible and probably will be excavated to a depth such that its swelling characteristics can be controlled. The general terrain is sparsely covered with light brush except for the Fourmile Bench, itself, which contains a light-to-medium concentration of junipers. The estimated cost for this segment is $7,300,000.

6. Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon. This 29.8 mile segment will contain a 7.5% continuous grade of 0.7 mile in Wesses Canyon. The remainder of the vertical alignment will be 4% and less. Wesses Canyon is a very narrow bottomed canyon somewhat similar to Tommy Smith Creek, Fourmile Creek, and Smith Run Canyons. It will be necessary to cross 13 streams on this segment. The geology, vegetation and aggregate situations are very similar to those of paragraph B.5. above. The estimated cost for this segment is $9,300,000.

7. Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon. This segment would be approximately 45.6 miles long and have 43 stream crossings. A maximum grade of 6.8% continuous for 1.4 miles, would be required on this segment. All other grades would be less than 5%. Last Chance Creek and Paradise Canyons are typical steep and narrow canyons very similar to those mentioned earlier. The geology, vegetation and aggregate situations are, again, very similar to B.5. above. The estimated cost for this segment is $16,000,000.

8. Fourmile Bench to Coal Mine via Paradise Canyon and Last Chance Creek. This segment is identical to the northern half of B.7. above and is 21.1 miles in length. Included is the long 6.8% grade and 22 stream crossings. The estimated cost for this segment is $8,600,000.

9. Nipple Spring to Coal Mine via a portion of Segment B.7. above. This segment is identical to the center third of B.7. above and is 12.9 miles in length. Road grades would be less than 3% and 16 stream crossings would be included. The estimated cost for this segment is $3,700,000.

10. Mouth of Wesses Canyon to Coal Mine. This segment is a part of B.9. above and is 2.4 miles long with 9 stream crossings and no grades steeper than 3%. The estimated cost for this segment is $900,000.

11. Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon. A 41.2 mile road with 8 stream crossings and a 7.5% continuous grade for 0.7 mile in Wesses Canyon plus a 6% continuous grade for 1.5 miles at the top of Missing Canyon. Once again, vegetation is very sparse until Fourmile Bench is reached. An exposed layer of shale is found quite extensively in the section from Glen Canyon City to Warm Creek. This shale exhibits very poor road building characteristics and should be kept moisture free and may have to be excavated to a depth such that its swelling characteristics can be negated. Aggregated sources would be Wahweap Creek and Horse Mountain with small quantities found in Warm Creek. As indicated above, Wesses Canyon is a very narrow bottomed canyon somewhat similar to Tommy Smith Creek, Fourmile Creek and Smith Run Canyons. The estimated cost for this segment is $14,600,000.

Segments B.2., B.3. and B.4. provide access from the Cannonville Road to U.S. 89 near Glen Canyon City, but do not provide direct access to either the mine or the plant sites. Accordingly, the alternatives shown in the Tables beginning on Page 9 do not include these segments. They are included in this Study to show various ways to provide a through north-south route which might be separate and somewhat apart from the plant and mine themselves.

It should be pointed out that the Glen Canyon to Warm Creek section of segment B.11. is common with the primary road alignment proposed in the Glen Canyon City to Bull Frog Basin Study. This Study is scheduled to be presented to the U.S. Congress sometime during October-November, 1974. Utilizing this section for both highway proposals could be a money saving action if acceptable to all parties involved. The National Park Service has expressed some reservation on this course of action as they feel that Congress may direct that the road to Bull Frog Basin be restricted to recreation use only.

Segments B.7. and B.8. appear to go quite a ways out of direction between the coal mine and Fourmile Bench. However, there are other potential coal developers who are working in the area adjacent to Last Chance and Paradise Canyons. These particular segments would appear to provide the best access to these developers should they decide to develop a mine or a plant near their exploratory drilling sites.

C. Nipple Bench Access Roads

Nipple Bench can now be reached by existing jeep trails which allow for fair weather and limited vehicle access only. As a minimum, these jeep trails would have to be leveled and widened to bring them to a condition that will allow construction crews and equipment to get to the plant site. The segments outlined below are to be used in conjunction with the segments outlined in Paragraph B. above. Segments which will provide the added access to reach Nipple Bench are as follows:

1. Nipple Spring to Nipple Bench. This road segment would be approximately 3.9 miles long, with no grades steeper than 4%. Nipple Bench has very little vegetative cover other than scattered small brush. This segment would contain no stream crossings. Aggregate would be brought from Wahweap Creek. The estimated cost for this segment is $800,000.

2. Warm Creek to Nipple Bench via Tibbet Canyon. This segment is 10.3 miles long and contains 5 stream crossings, and has no grades steeper than 3%. This route is only sparsely vegetated with light brush and very few trees. Some aggregate can be found in Warm Creek, but additional will have to be brought from Wahweap Creek. The estimated cost for this segment is $4,700,000.

D. Maintenance and Road User Costs

Estimates of maintenance costs were based on actual maintenance performed on U.S. 89, Kanab to Arizona State Line, and State Route 12, Bryce Canyon to Boulder. Included in the maintenance cost are such items as snow removal, seal coating, lane leveling, stockpiling, paint striping, pot hole patching, litter pick-up, etc. Although maintenance needs should not be too great in the first year or two after construction, the average annual maintenance cost per mile used in this Study only deals with future years which are some years beyond initial construction. For this Study, the annual maintenance cost is approximately $1,300 per mile of roadway.

Road user costs were developed from data supplied by the Weber State College Center for Business and Economic Training and Research as a part of an on-going consultant contract which they have with the Department of Highways. A portion of the information which follows has been extracted from the data provided by this consultant.

Road user costs are those expenses incurred in the operations of a vehicle on a highway. The primary components of user costs are (1) vehicle operating expenses, specifically fuel, oil, tire, maintenance and insurance expenses, and (2) the cost of accidents. The magnitude of operating costs and the incidence and cost of accidents vary in relation to particular highway design characteristics (grades, curves, surface), driving conditions, speeds, types of vehicles, etc. Each of the aforementioned highway design characteristics has a considerable bearing on cost required to operate each different type of vehicle. At this time, the horizontal and vertical alignments plus vehicle mix (cars, heavy truck, buses, etc.) are all subject to considerable change based on future detailed highway design and analysis of expected traffic mix. If all of these factors were known, an operating cost per mile could be computed for each individual alternate. However, based on the limited and preliminary data available at present, a constant figure of $0.0745/mile has been used for this Study. Accident cost data was based on an incident rate of 5.99 accidents per million miles of vehicular traffic on similar type facilities and an average of $1,500 per accident (data derived from 1973 Utah accident statistics). Note also, that the results of this evaluation will be invalidated if a mass transit service is provided for the employees. In determining the vehicle miles on each route, a vehicle occupancy rate of 2 employees/vehicle, with each vehicle completing a daily round trip from the community to a work site was assumed. A bus system would alter significantly the number of daily vehicle miles along each route and thus change the base from which this evaluation was made.

A particular highway can be appraised in terms of user cost by estimating the traffic volume along the route and identifying the associated operating and accident expenses of traveling that route. This approach was used to evaluate the alternate access roads proposed for the Kaiparowits power plant area. The primary use of the access roads will be commuter traffic -- approximately 500 plant operators and 2,100 coal miners will be employed in the area. While there will be some recreation and utility maintenance traffic on the facilities, it is assumed that the volume and distribution of this non-commuter traffic will remain relatively constant regardless of the access road selected.

As indicated above, estimates of road user costs provided in this Study do not include any estimates for traffic other than the internal Kaiparowits commuter traffic. It is interesting to note, however, that a comparison of distances from Glen Canyon City to Cannonville (see Tables II and V) tends to separate the access road alternates into two general groups, i.e., Alternates A and B, or L and M (approximately 60 miles through distance), and Alternates C and D, or N and O (approximately 75 miles through distance). Road user costs for motorists traveling from Glen Canyon City to, and through, Cannonville would tend to favor Alternates A or B (L or M) over C or D (N or O). The mileage difference between Alternates A (L) and B (M) is small enough that it is hard to favor one over the other based on total distance only.

Based on varying assumptions as to the location of the plant, mine, and community, volumes of commuter traffic were calculated for each of the proposed alternates. Applying the accident and operating expense per mile factors to these volumes resulted in estimates of the user costs of traveling along each route. Tables III and VI on Pages 11 and 14, respectively, present a summary and comparison of the annual user costs for each alternative.

One component not incorporated into this evaluation is the time difference involved in traveling the specified routes. Travel time is also very dependent upon items such as vehicle mix, driving speeds, horizontal curves, vertical grades, etc. Another factor subject to wide differences of opinion is the value of a person's time in dollars and cents. It is for these reasons that no consideration has been given to travel time in this Study.

TABLE I. FOURMILE BENCH - AGGREGATE REQUIRED AND CONSTRUCTION COSTS

Route Description	Segments Involved*	Total Mileage	Aggregate (Cu. yds.)	Estimated Road Cost
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	72.9	874,800	$25,500,000
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10	65.0	780,000	$24,700,000
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	80.4	964,800	$30,500,000
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	76.0	912,000	$29,100,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE II. FOURMILE BENCH - COMMUTER DISTANCES (MILES)

Route Description	Segments Involved*	Butler Valley		Clark Bench		Glen Canyon City to Cannonville
		to Plant	to Mine	to Plant	to Mine	
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	19.2	45.8	25.2	24.4	60.0
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10.	19.2	26.3	32.8	24.4	61.6
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	19.2	35.8	50.1	24.4	75.8
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	19.2	26.3	45.1	32.0	73.9

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE III. FOURMILE BENCH - MAINTENANCE AND ROAD USER COSTS

Route Description	Segments Involved*	Maintenance Cost/Year	Road User Cost/Year	
			Butler Valley	Clark Bench
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	$ 94,800	$2,208,000	$1,333,000
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10.	$ 84,500	$1,353,000	$1,412,000
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	$104,500	$1,770,000	$1,593,000
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	$ 98,800	$1,353,000	$1,874,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE IV. NIPPLE BENCH - AGGREGATE REQUIRED AND CONSTRUCTION COSTS

Route Description	Segments Involved*	Total Mileage	Aggregate (Cu. yds.)	Estimated Road Cost
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	76.8	921,600	$26,300,000
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	68.9	826,800	$25,500,000
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	84.3	1,011,600	$31,300,000
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	86.3	1,035,600	$33,800,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE V. NIPPLE BENCH - COMMUTER DISTANCES (MILES)

Route Description	Segments Involved*	Butler Valley		Clark Bench		Glen Canyon City
		to Plant	to Mine	to Plant	to Mine	to Cannonville
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	36.8	45.8	15.4	24.4	60.0
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	38.3	26.3	15.4	24.4	61.6
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	52.5	35.8	15.4	24.4	75.8
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	51.9	26.3	27.0	32.0	73.9

* Refer to corresponding paragraphs in this report with the same sub-heading.

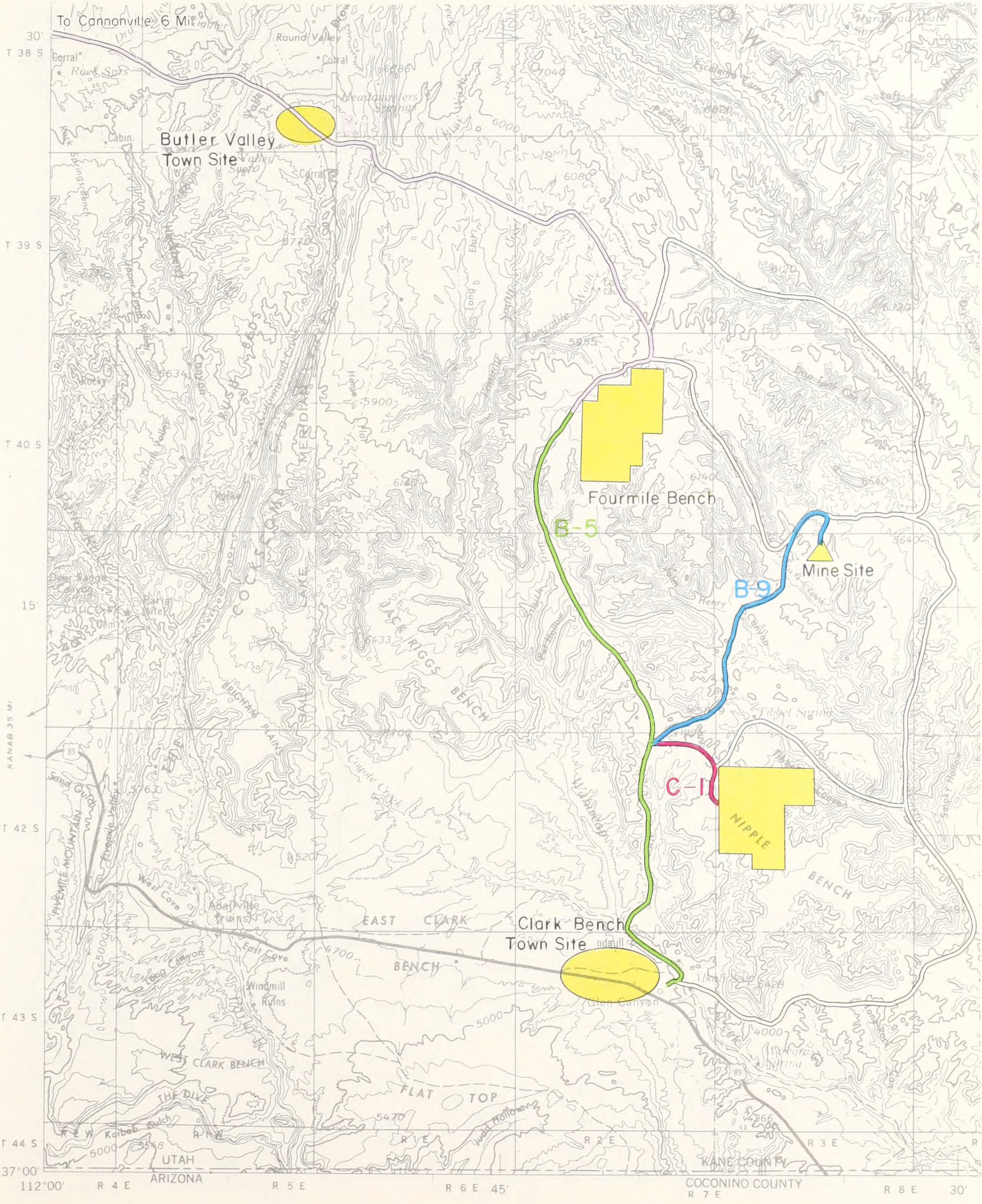
TABLE VI. NIPPLE BENCH - MAINTENANCE AND ROAD USER COSTS

Route Description	Segments Involved*	Maintenance Cost/Year	Road User Cost/Year	
			Butler Valley	Clark Bench
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	$ 99,800	$2,392,000	$1,230,000
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	$ 89,600	$1,553,000	$1,230,000
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	$109,600	$2,117,000	$1,230,000
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	$112,200	$1,695,000	$1,685,000

* Refer to corresponding paragraphs in this report with the same sub-heading

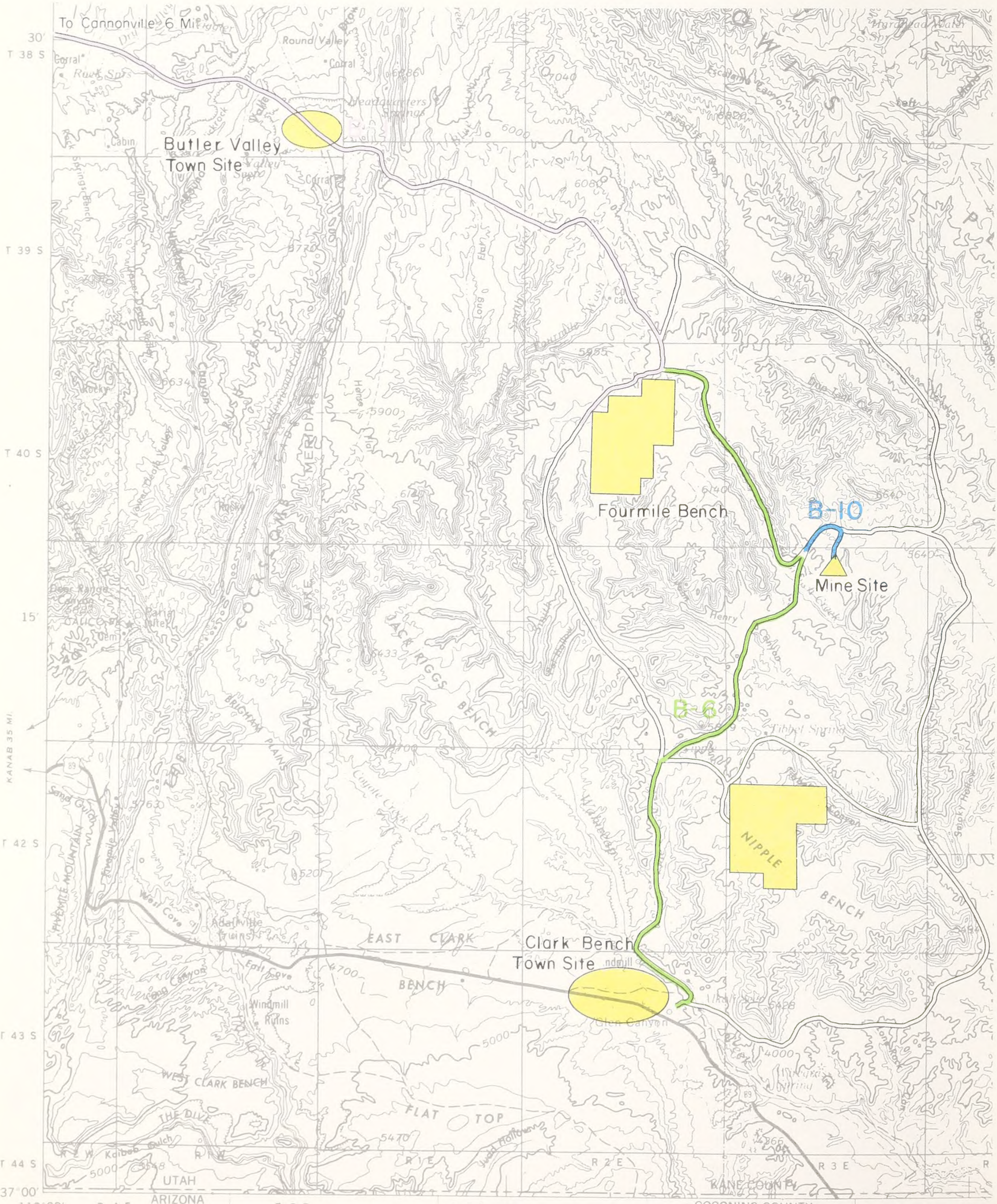
FOURMILE BENCH AND NIPPLE BENCH

ACCESS ROAD ALTERNATES



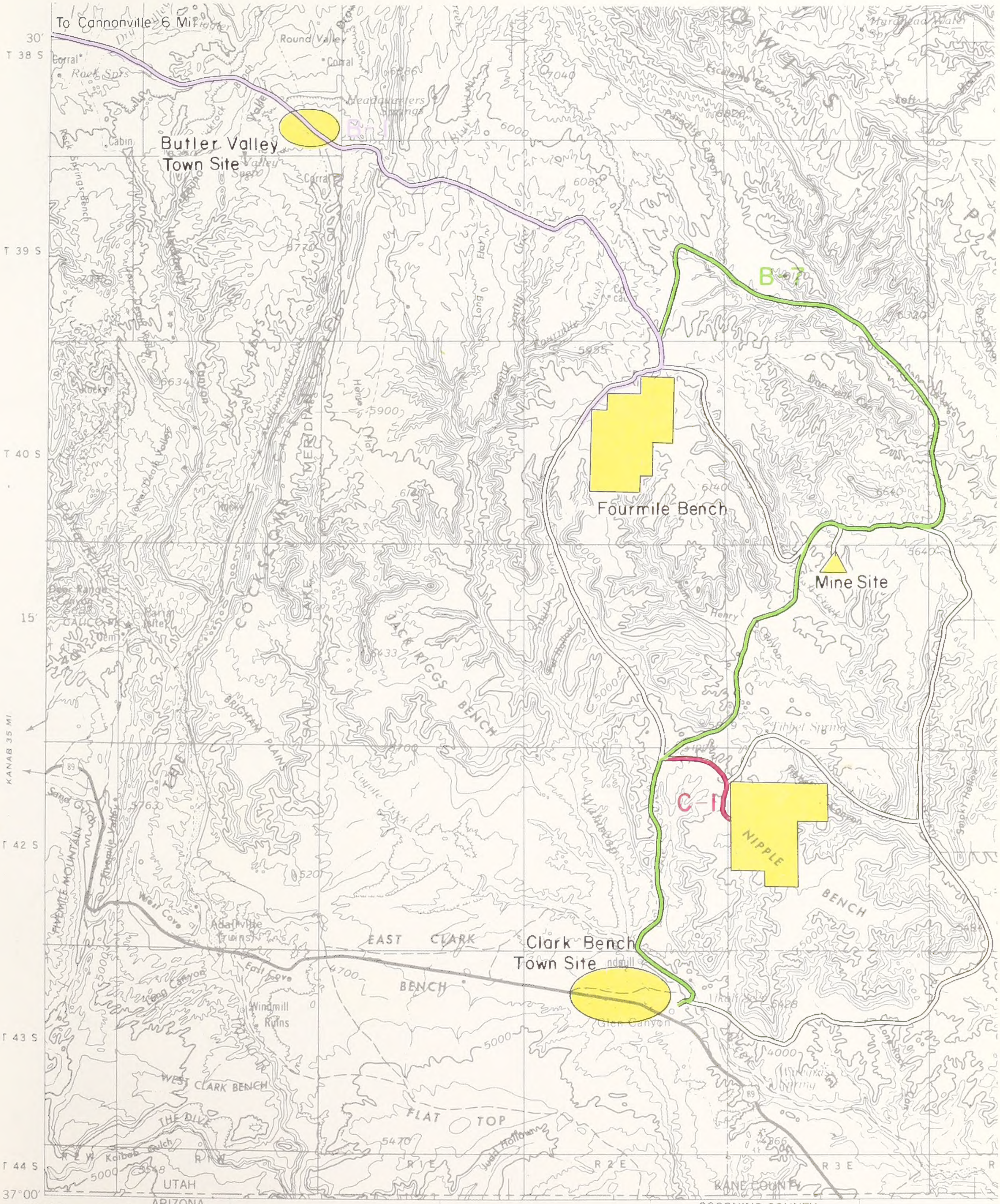
FOURMILE BENCH AND NIPPLE BENCH

ACCESS ROAD ALTERNATES



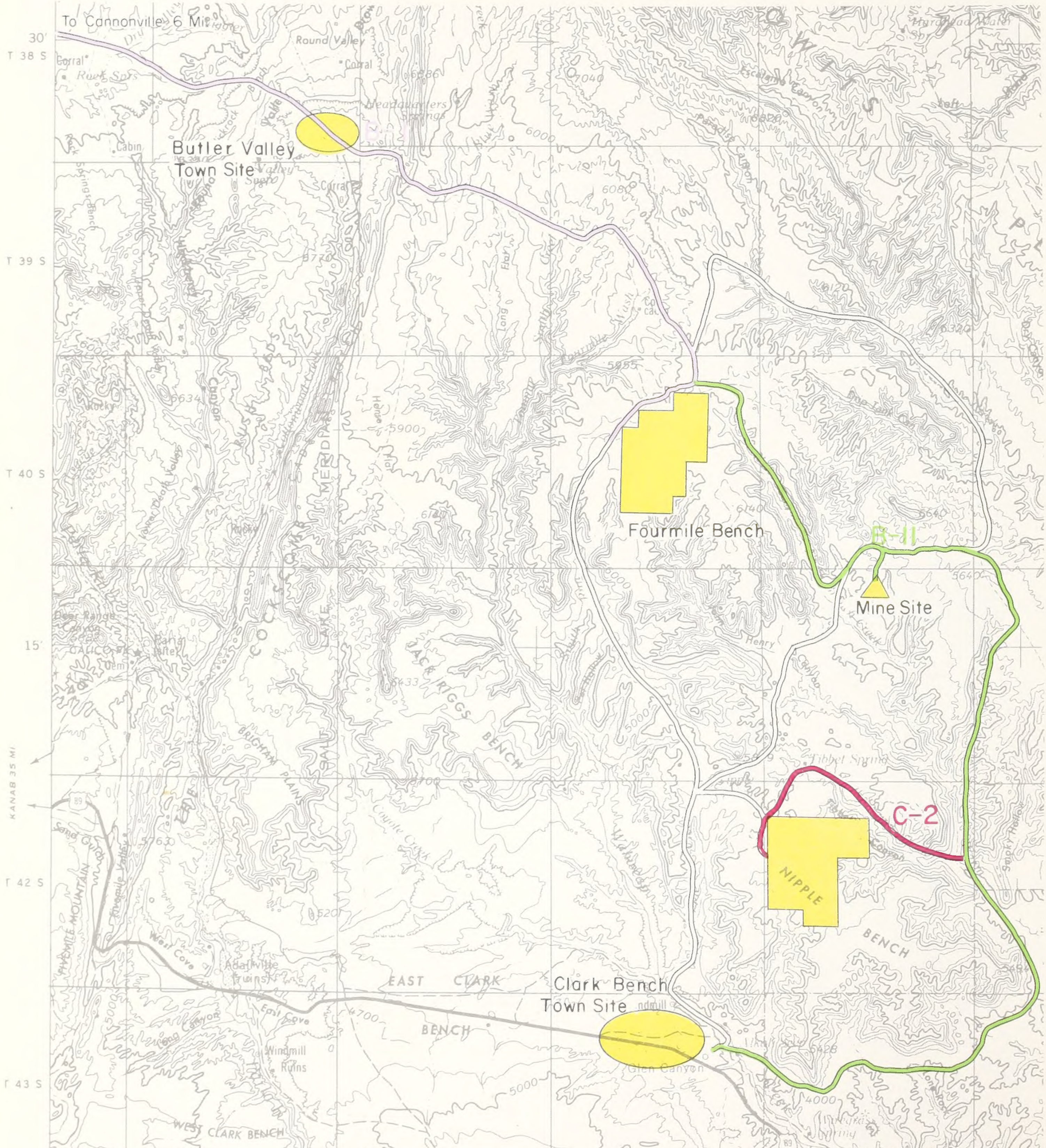
FOURMILE BENCH AND NIPPLE BENCH

ACCESS ROAD ALTERNATES



FOURMILE BENCH AND NIPPLE BENCH

ACCESS ROAD ALTERNATES



APPENDIX I - 14

Contingency Housing Plans
Kaiparowits Generating Station

Southern California Edison Company

P. O. BOX 800
2244 WALNUT GROVE AVENUE
ROSEMEAD, CALIFORNIA 91770

March 18, 1975

Mr. Frank Snell
E.I. S. Team Core Leader
Bureau of Land Management
Federal Building Annex
135 S. State St.
Salt Lake City, Utah 84111

Dear Frank:

Subject: Contingency Housing Plans
Kaiparowits Generating Station

In response to your request, we wish to confirm having handed you on December 4, 1974 the Companies' Contingency Housing Plan, copy enclosed. Your current (January) draft of the EIS incorporated our plan and reflects our commitment to provide facilities if required to mitigate service lag in the development of the permanent new community. In light of recent legislation passed by the Utah State Legislature, it seems unlikely that the Contingency Housing Plan will ever be required. For your information, the pertinent bills are described briefly as follows:

Senate Bill 231 UTAH SPECIAL SERVICE DISTRICT ACT

Provides for the formation and operation, as separate entities, special service districts. Provides for the governance and for the powers of these districts, including services to be performed, the levy of taxes and the issuance of bonds.

Senate Bill 256 RESOURCE DEVELOPMENT ACT

Establishes state policy regarding public improvements connected with Development of Natural Resources and with regard to sales or use tax by those engaged in developments involving Natural Resources; provides for the expenditure of these prepayments by the State Road Commission and State Board of Education to finance highway and school construction.

Senate Bill 257 BUILDING SCHOOLHOUSES

Provides procedural requirements for school districts to raise funds for school construction required due to new industrial plants, (bonds, tax levy and applications to Federal Government); allows school districts to enter into contracts (lease-purchase agreements) with developers of industrial plants; restricts issuance of state or local construction permits until Board of Education of the district certifies that funds are/or will be made available to construct minimum school facilities if required.

Passage of the bills has provided a source of "front-money" for highways, schools and other public improvements, thereby enhancing the likelihood that the new community and services will be available when required.

We trust that the above will satisfy your request for a formal commitment by the Companies to the Contingency Housing Plan.

Sincerely,

R S Currie

R. S. Currie
Project Manager
Kaiparowits Power Project

Enclosure

CONTINGENCY HOUSING PLAN

The proposed action for housing of the construction work force incorporates a 400-600 man bachelor camp at the site and the development of the early phases of the permanent new town in a time frame to support the workers coming to the site with family.

Contingency planning has been initiated by the participants in order to be prepared in the event that the permanent new town development does not get underway in a time frame to support the workers with family. At this stage the contingency planning consists of a study done by a consultant in the field of economics, and a preliminary concept proposal by a temporary town developer.

The economic study addresses optimum siting, preliminary estimates of the number of housing units required versus time, and preliminary estimates of the features required (recreational, health, educational, etc.). The temporary town developer used this data to propose a possible concept to meet these needs.

A summary of these two efforts is included below. As permanent new town development plans and activities take form it will become evident whether the contingency planning must be expanded and finalized.

ECONOMIC STUDY

The site selection analysis was performed to determine the optimum location for a temporary community for construction workers in the event the new town development does not begin in time to meet construction worker housing needs. The study considered two potential plant sites; one at Four Mile Bench, located approximately 13 air miles north of Glen Canyon City; one at Nipple Bench, located approximately 7 air miles north of Glen Canyon City.

STUDY APPROACH

In order to ascertain the optimal worker housing site location, reliance was placed upon both primary and secondary research activities. Primary research efforts included:

- Field inspection and analysis of the Kaiparowits region extending from Glen Canyon National Recreation Area to Kanab, Utah;
- Interviews with municipal officials regarding provision of services at alternative locations; and
- Discussions with the new town planning/engineering consultant regarding site development and engineering parameters pertinent to optimal site selection.

Secondary research included, but was not limited to:

- Analysis of geotechnical data and topographic information gathered from Southern California Edison and various public and private agencies regarding potential worker housing community location; and
- Analysis of various in house reports prepared by Southern California Edison concerning plant and community location and resultant social and physical problem areas.

SELECTED COMMUNITY SITE AREAS FOR FURTHER INVESTIGATION

Five alternative sites were evaluated as possible locations for the temporary worker housing community. Engineering factors which contributed to this formulation were:

1. A minimum requirement of 600 acres of developable land,
2. Slope not to exceed 10 percent,
3. Physical accessibility to the plant and mining sites,
4. Soils quality deemed physically feasible for community development, and
5. Feasibility of supplying site with water system and utilities.

The five alternate community sites chosen for investigation, oriented to specific generating station locations, were as follows:

Nipple Bench Alternate Plant Site

1. **Glen Canyon City - East Clark Bench Community Site - current site of the proposed permanent new town facility, located approximately 7 miles south of Nipple Bench plant site.**
2. **Nipple Bench Community Site - located approximately 2½ miles south of the Nipple Bench plant site.**
3. **Nipple Springs Community Site - located approximately 9 miles north of Glen Canyon City.**

Four Mile Bench Alternate Plant Site

4. **Long Flat Community Site - located approximately 6 to 8 miles to the north-northwest of the Four Mile Bench alternate plant site.**
5. Butler Valley Community Site - alternate new town site, located between 12 and 15 miles north-northwest of the Four Mile Bench alternate generating station site.

Physical Factors - The following physical factors were determined to be crucial to successful site development:

1. Slope
2. Soils
3. Climate
4. Natural Vegetation
5. Hydrology - Drainage Potential

Environmental Factors - Two major environmental factors were considered important to the temporary community locational analysis. The first element relates to environmental damage generated by infrastructure recycling. The second consideration is that community development does not cause significant environmental damage to surrounding areas.

Political/Governmental Factors - The primary parameter associated with the public sector was that the temporary community's location will meet with approval from Kane County, Utah.

SITING CONCLUSIONS

On the basis of the locational analysis, the sites considered optimal for temporary community development were determined to be

Numbers 1 and 5, the two alternate new town site alternatives under consideration. The basic findings which support this conclusion were as follows:

- Site Numbers 1 and 5 both provide superior overall access to all potential regional destinations.
- Sites 1 and 5 should both provide excellent amenity value and environmental quality for community residents. Site 1 has excellent amenity potential associated with Lake Powell, while Site 5 is rich in visual quality.
- Housing stock and infrastructure recyclability should be excellent at Sites 1 and 5 since both sites are alternate new town locations.
- The development and recapture costs of infrastructure and housing should be minimal at Sites 1 and 5 since they are alternate new town sites.
- Development costs accruing to Southern California Edison should be minimized at Sites 1 and 5 since the joint location of the new town and temporary community should exhibit economies of scale with respect to construction and disposition expenses.
- The primary physical problem associated with Sites 2, 3, and 4 is poor soil quality. The two alternate new town sites provide a comparatively better soil base for community development, while the remaining sites would cause several significant engineering-technical problems related to hard rock ground surfaces.
- The location of both the temporary community and the permanent new town at the same site minimizes potential environmental damage exposure since only one location faces potential damage.
- Kane County taxpayer liability is minimized at Sites 1 and 5 because public services may be financed out of permanent new town assessed valuation, rather than low-value temporary and mobile oriented development.

In summary, it is concluded that a temporary community development should be sited at the location of the new town (Site 1 or Site 5), if a new town development is not undertaken in a time frame to support construction workers with families.

HOUSING UNITS (QUANTITY)

Based on both project construction and secondary employment-related population, it is projected that the range of required housing units for the temporary construction community will increase according to the following schedule. The data presented are current projections and subject to revision as more finite information is developed.

- o By the third year of project development, plant construction employment will increase significantly. In addition, competing housing projects in the surrounding vicinity will be reaching maximum capacity, thus leading to the significantly increased project capture rates.

COMMUNITY FEATURES

Community features which will be included in the temporary worker housing complex are:

- o Community recreation center including tennis courts, swimming pool, field sports areas and community building for town meetings and special events,
- o Community park for picnics and social events,
- o Children's center, including day care facilities for working wives,
- o Storage areas for boats and recreation vehicles.

Temporary community housing unit features will include the following:

- o If mobile home units are utilized, a complete package should offer furniture and major appliances,
- o Paved driveway and storage space for second car or small recreation vehicle,
- o Carpets and drapes,
- o Covered balcony or patios,
- o Air conditioning,
- o Cable television hook-ups,
- o Orientation to view potentials. and
- o Individual unit fencing

GOVERNMENTAL ELEMENT

The temporary community must provide equal or even greater public services than are provided for residents of existing communities in the area if it is to capture a significant amount of construction housing demand. Specific services which should be provided at the temporary community are as follows:

1. Education
   - a) Junior High School and High School in one facility, grades 7-12,
   - b) Elementary School, grades 1-6
2. Police Protection - Full time patrol
3. Fire Protection - Located within town boundaries or in close proximity
4. Post Office
5. Local Parks - Component of new town plan
6. Health Services - Small hospital and out-patient clinic
7. Library - Portable bookmobile for interim construction period with permanent facility part of school development program
8. Pest Control
9. Refuse Collection and Disposal.

It is anticipated that coordination among the applicant, the developers, state and Kane County officials would be necessary to carefully determine levels of service.

CONCEPT PLAN FOR CONSTRUCTION HOUSING

A temporary community for field construction personnel could be developed in stages at a site having reasonable access to the construction site. Necessary support facilities would be provided in the community.

The plan outlines an approach to providing housing based upon specific objectives and assumptions, and includes a Concept Plan which is phased to meet the projected housing needs for construction workers. It is presumed that this community can be built at the site of the proposed New Town and that parts of the temporary town can be adapted to become a permanent part of that proposed community.

OBJECTIVES

The Contingency Plan is based upon two primary objectives: 1) to provide convenient housing for construction workers in the event that housing is not yet available from the proposed New Town; and 2) to develop the community at sufficiently high standards and with adequate amenities to not only attract qualified construction personnel, but also to reduce the turnover rate for employees to the greatest extent possible.

The provision of housing for construction workers within commuting range of the Kaiparowits construction site is an unavoidable preliminary to construction. There are few available workers within commuting range of the Kaiparowits site and virtually no housing available for new workers. In providing housing, an additional opportunity is open--namely, designing the housing so that it in itself becomes an inducement and attraction to workers.

ASSUMPTIONS

In developing the Concept Plan, it has been assumed that the construction community would be built at the site of the proposed permanent New Town. This anticipates that a decision will have been made as to the specific location of the New Town site. This assumption has been made primarily because of the overwhelming logic that supports the installation of utilities, roads, and other infrastructure, and schools, shopping, recreation and other community facilities which are permanent or which can be re-used as a part of the New Town. The high cost of providing such utilities and facilities cannot be easily justified unless there is a long and permanent application for them. Moreover, the essential objectives of attracting and retaining workers require that these facilities be of reasonably high standards, and the higher costs of obtaining quality in the community can be better justified if the improvements are permanent.

It is assumed that the permanent New Town would be under active development within four years of the start of construction of the generating facility. The construction community is therefore phased over three years as Contingency Plan which would adequately cover the longest probable period of delay.

It was also assumed that the site is reasonably level and that no unusual problems of providing utilities would be encountered. It is assumed that a package treatment plant would be provided off the site and that sewers, water lines, and other utilities would be sized so as to become a permanent part of the community. Community facilities such as schools, fire station, recreational facilities and the like are assumed to be a needed part of this community, but no assumptions have been made at this time as to the governmental agencies required to administer and operate these facilities. It is assumed that the implementation program for the permanent New Town will address this problem and that those recommendations can be adapted to the operation of any facilities that are provided.

It is also assumed that a highway will be extended through the New Town site, and that this highway would be the principal traffic artery for the New Community.

APPROACH

Before developing a Concept Plan, it was necessary to anticipate the generalized form that the permanent New Town would have. A sketch of this anticipated form is shown on the attached plate. It assumes that a large core area would be surrounded by principal traffic arteries and would contain in a centralized area the business district, municipal facilities, and the institutional (educational, cultural, recreational, and religious) facilities for the entire community. Surrounding this core are residential neighborhoods. The number and size of neighborhoods is a function in part of the project growth of the community, and in part of the long term growth prospects of the New Town. The sketch shows six residential neighborhoods and an area for future industrial development. While no effort has been made to qualify the specific needs of the future New Town, the sketch anticipates that approximately 2,000 acres would be devoted to residential area, with about 500 acres devoted to the Town Center, and an indeterminate amount reserved for future industrial growth.

The circulation system is based upon the main highway which will become a loop around the Town Center. The highway separates the residential neighborhoods from the Town Center, and collector roads branch off of this to provide principal access into and through the residential communities. Housing is clustered on loop roads or cul-de-sacs which branch off the collector roads. Secondary connections between neighborhoods are provided, but are intended only for low intensity traffic to give convenient access to the elementary school playground facilities and between neighborhoods.

Residential Development

Two categories of dwelling units are proposed for the site--mobile homes and modular homes. The mobile homes occupy neighborhood clusters identified by the letters A through G on the Concept Plan. The modular homes occupy those neighborhood clusters identified by the letters H through L on the Concept Plan.

The mobile home lots have an average size of 50 x 150 feet, and the units are clustered so as to provide convenient access to recreational facilities. These lots can be easily modified after completion of the construction phase to use for permanent dwellings by combining two lots into one.

The modular homes are located on larger lots in separate neighborhoods. The lots for the modular homes average 65 feet in width by 175 feet in depth. These lots are intended to be permanent lots, and ample space is allocated so as to allow for room and privacy for each family. Individual lots for both categories of housing are located on cul-de-sacs or loop streets which branch off a collector road. Since no driveways have direct access onto the collector road, the road can function with greater safety and less traffic conflict as an arterial serving the neighborhood.

The Concept Plan proposes a similar layout of cul-de-sacs and roads. The smaller neighborhoods which result should facilitate social interchange among the new and transient members of the community and should facilitate traffic safety in the neighborhoods. The individual neighborhood clusters are separated by open space which can be utilized as pedestrian ways providing walking and bicycling paths which are generally independent of the vehicular road system. The pedestrian paths lead to larger open spaces which are utilized for parks and playground facilities.

Educational System

The rapid growth of population will require the installation of an educational system and at as early a time as possible. The Concept Plan anticipates that a school would first be built between the two residential neighborhoods which will become an elementary school, but would serve originally as the sole educational facility serving the community. Until this first school is built, students could be bused to existing schools within the region.

The Concept Plan calls for an expansion of the school facilities in the Town Center area to accommodate a secondary educational program. Such facilities must obviously be carefully interrelated to the plans for the permanent New Town. It is assumed by the Concept Plan that a central educational facility can be developed in accordance with its own Master Plan to ultimately provide for a middle school, a high school, and specialized facilities such as a gymnasium, auditorium, cafeteria and the like. The growth of the population in the construction community as shown on the Concept Plan would require that the secondary school be constructed during the third year in order to accommodate the large number of children and in order to provide more specialized educational facilities. Space for the athletic facilities for the secondary educational facility would be located adjacent to that facility in the Town Center.

Recreation

Through the three years anticipated by the Concept Plan, four playgrounds and a recreational center would be provided. The playgrounds are relatively small and located adjacent to the residential neighborhoods. The largest of these would be located adjacent to the elementary school and would provide recreational facilities and playground facilities for the students as well as for the residents of the neighborhood.

The recreational center is proposed for early construction in the Town Center. It will have a community building, a swimming pool , and other appropriate recreational facilities. The community building would constitute the social center of the neophyte community and, as such, has an extremely high priority. Social functions should be programmed to maximiz opportunities for leisure time activities for the residents. This is particularly important in this remote location during the early stages of the community's development. The building could also serve on an interim basis for religious services, and as a day-care center. (The shortage of workers in this new community will place a premium on working wives.)

Commercial

Commercial facilities should be expected to expand proportionately to the population, since the distance to alternative shopping facilities is substantial. The Concept Plan anticipates that a future shopping center would be developed in the Town Center, and that portions of this can be installed at an early phase in order to provide convenient shopping for the residents. It is anticipated that this could be accommodated through the construction of a universal space structure which can be subdivided to accommodate interim shopping needs, and re-subdivided later to respond to changing markets and changing commercial needs. A prefabricated structure of durable construction is proposed for this facility.

A motel is also proposed near the shopping center to accommodate new arrivals, itinerants, and housing overloads which may occur from time to time. A restaurant would also be provided at the motel site.

Health

A small clinic is proposed in connection with the municipal building to accommodate health services. It is anticipated that health services would be provided primarily by a nurse or para-medic team until the population reaches a point where it can support a doctor and attendant medical facilities. Emergency access to some hospital in a nearby community should be provided.

Safety

The municipal building would also provide facilities for fire protection and for policing the community. Management of the community would also require space at the municipal building . A durable, high quality, pre-fabricated building may serve as the municipal building during the early stages.

PHASING

Phasing of the construction community is shown on plate ____. It anticipates a three-year construction period predicated on the assumption that the permanent community may not be developed in time to meet the housing requirements for construction workers, but that in no case will it be delayed more than three years from the start of the construction of the Kaiparowits Project. The numbers of units are based roughly on the projected requirements for housing as indicated in the economic report. The actual number of units which are provided vary somewhat from the above cited report, but detailed scheduling and adjustment of the Plan can accommodate a number of variables which may arise.

First Year

The first year calls for the construction of a 100-unit motel near the main entrance of the community which will accommodate construction workers at the site and will provide housing for newly-arrived and itinerant workers.

Two housing clusters would be completed within the first year--those labeled A and H. Cluster A would accommodate 35 mobile homes, Cluster H 35 modular homes. A playground, which eventually would become a playground serving the elementary school, would be begun during the first year to provide recreational facilities for the first residents. In addition, the sewage treatment plant to serve the projected development would be constructed off the site.

Second Year

During the second year, 565 mobile homes would be installed and 325 modular homes. A 16-classroom elementary school would be constructed and would serve initially as the central educational facility for the entire community, housing all grades under one roof. The recreational center would be constructed during this year and would provide the community building, swimming pool, and areas for court games. The municipal building would be started during the second year to provide fire protection and a clinic. The first phase of a future shopping center would also be completed to provide approximately 12,000 square feet of shopping area to accommodate needs of the residents. Altogether, 890 dwelling units would be installed during the second year, bringing the total number of units available to 960, not counting the 100-room motel.

Third Year

During the third year, 640 mobile home units and 425 modular units would be constructed. These 1,065 units would bring the total units available to 2,025. In addition, two playgrounds would be installed, the secondary school complex would be initiated, a library would be added to the municipal building and the clinic would be expanded. These facilities should, of course, dovetail into the planning and programming of the permanent town.

SUMMARY

The Concept Plan provides for a phased development of housing for construction workers over a satisfactory period of time to assure that the permanent New Town can be underway to meet subsequent housing needs. The Contingency Plan anticipates a delay of up to three years between the start of construction of the Kaiparowits project and the actual development of the permanent new community. It allows for the construction of more than 2,000 housing units in a framework that can be adjusted both upward or downward to accommodate any variation in the projected housing requirements.

The Concept Plan is adaptable to various forms that may be developed for the permanent New Town, and will be developed so that it can become a permanent part of the new community. The mobile home units may remain as a mobile home park if the need for such a facility is evident, or the mobile home units may be removed and every two mobile home lots would then become one permanent lot in the permanent community.

An adequate level of community support facilities is projected by the Contingency Plan to meet the needs of the construction workers, and these facilities can be adapted to permanent use within the new community. The streets and circulation system are designed to function not only on the interim level, but also to provide permanent traffic facilities for the new town and to accommodate growth through the future of that town.

The Economic Study and the Concept Plan are preliminary. They form a contingency plan assuming that the permanent New Town development does not proceed in a time frame to support the construction work force buildup. As the permanent New Town development plans take form it will become evident whether the contingency planning must be expanded and finalized.

APPENDIX I-15

Kaiparowits Coal Quality Update

KAIPAROWITS COAL QUALITY UPDATE

Summary

Development of the Kaiparowits Project coal mining plan relative to the coal preparation process has resulted in a recent update of the Kaiparowits coal quality analysis. The coal quality analysis presented in the Kaiparowits Draft EIS was based on a range of drill core values undergoing a partial wash coal cleaning process. The updated coal quality analysis represents current coal preparation design and is based on a representation of the expected range of clean coal product which has undergone a full wash process in a preparation plant.

The resulting reduction in ash and sulfur content presented in the updated Kaiparowits coal quality analysis is a direct result of the further development and more detailed analysis performed in formulating the current coal preparation process as applied to the Kaiparowits coal. A discussion documenting the development of the Kaiparowits coal drilling program, cleaning process, and coal quality analysis and a comparison between the original and updated coal quality analyses is presented below.

Historical Background

A short history of the drilling program of the Kaiparowits coal deposit on the leasehold that will supply coal for the Kaiparowits Project will assist in tracing the development of the determination of the quality of Kaiparowits coal. Forty core holes were drilled in the period 1963-1964 for the primary purpose of proving the existence of a commercial coal deposit which would enable the holders of the Federal coal prospecting permits to convert their holdings into preferential coal leases. Cores were obtained from all of the coal seams in these 40 holes. Only a limited amount of coal quality data was obtained from these cores before the exploration program was suspended pending results of obtaining an allocation of water from the State of Utah and a water service contract with the U. S. Bureau of Reclamation. Following the allocation of 102,000 acre-feet per year of water by the State of Utah in late 1965 and three years of negotiation with the Bureau of Reclamation (1966-1969), culminating in a water service contract in late 1969, a development drilling program was commenced in 1970 under the management of Bechtel Corporation. During the period 1970-1972 an additional 77 core holes were drilled to determine the extent, correlatability, quality, and washability of the coal seams anticipated to be mined. Approximately 100 core samples were analyzed by Commercial Testing and Engineering Company of Chicago, Illinois, and Denver, Colorado. Results of these analyses showed that the coal in place in the four minable seams had the following characteristics: 11,312

Btu's per pound as received, 8.75% moisture, 9.21% ash, 38.44% volatile matter, 43.57% fixed carbon, and 0.54% sulfur. The heating value of the "pure coal" was calculated on a moisture ash-free basis (MAF). The resulting MAF heating value was 13,788 Btu's per pound. It should be noted that this analysis was for cores taken from the in-place coal seams and contained no non-coal material from above or below the coal seam, but only such non-coal material as might be contained in "splits" (bands of rock or shale) within each coal seam. Based upon this basic coal quality data, it was determined from consulting mining and coal preparation plant engineers that a clean coal product could be produced by processing the component of the raw coal from the mines having a size one-quarter inch or larger through a preparation plant and bypassing the raw coal sized under one-quarter inch. These streams would be recombined to form a partially washed coal product having the following characteristics: 10,800 Btu's per pound, 12.55% moisture, 9.25% ash, 36.60% volatile matter, 41.60% fixed carbon and 0.52% sulfur. This partial washing process would produce a product having a higher ash content than a totally washed product, but a lower moisture content since a sizable portion of the raw coal stream would not be wetted. By eliminating the moisture and ash from this analysis, the MAF heating value of the pure coal would be 13,811 Btu's per pound. After Kaiser was selected as the mine operator, the methods of processing, washing and cleaning the raw coal to produce a clean coal product were re-evaluated. Based on this evaluation, it was determined that the optimum process would be to wash the entire raw coal stream and "spoil" the fines (100 mesh by 0), since it would be uneconomical to dry and recover the coal remaining in this size fraction. This process has the added advantage of not requiring a thermal dryer to dry this component, which would contribute to air pollution. The resulting coal product from this process would be a clean coal product having a heating value of 10,800 Btu's per pound, 14.8% moisture, 7% ash, 36% volatile matter, 42.2% fixed carbon, and 0.42% sulfur. Sulfur forms tests performed as part of the ongoing exploration program show that approximately 20% of the sulfur contained in the Kaiparowits coal is pyritic sulfur resulting in a full wash product having a lower sulfur content. The full wash process would produce a product having a lower ash content since the total coal stream would be processed, but a higher moisture content because the finer components would be wetted. The MAF heating value of this product would also be 13,811 Btu's per pound.

This last coal analysis also had the benefit of additional core analysis data obtained from the current drilling program consisting of 78 holes drilled during the period 1974-1975. Results of these latest tests and tests of cores from previous drilling programs were all performed by Commercial Testing and Engineering Company and indicate that the coal from the four minable coal seams all have a MAF heating value of approximately 13,800 Btu's per pound on average, with a narrow range of approximately 13,600 to 14,000 Btu's per pound. The foregoing resultant MAF values of around 13,800 Btu/lb in all cases indicate the relative uniformity of the Kaiparowits coal both laterally within each seam and from seam to seam.

Coal Quality Analysis Comparison

The difference between the coal quality data presented in the Kaiparowits Draft EIS and the updated coal quality data is a result of the following:

- o Change in coal cleaning process concept from a partial wash to a full wash scheme.
- o Representation of the expected range of clean coal product from the preparation plant rather than a range of drill core values.

Each of these changes and the quality parameters affected are discussed separately below.

1. Cleaning Process Concept

The original partial wash cleaning scheme bypassed the raw coal sized under 1/4 inch x 0 directly to the clean coal product. Only the component of the raw coal from the mines having a size 1/4 x 0 or larger was processed in the preparation plant. This led to a relatively high ash (9.25%)*, low moisture (12.55%) product since process water did not come in contact with the under 1/4 inch x 0 size fraction and high ash material was not removed from this fraction. Based on 21.8% inerts in the clean coal (9.25% + 12.55% = 21.8%) an as received heating value of 10,800 BTU/lb. resulted which was acceptable as power plant feed. However, an analysis of dilution expected during the mining operation from roof and floor indicated that the product ash obtained by bypassing the 1/4 inch x 0 fraction would be higher than 9.25% and therefore the clean coal product specification of 10,800 BTU/lb. could not be met utilizing the partial wash cleaning scheme. A full washing scheme was developed which produces a 7.0% ash product at 14.8% moisture. This product also contains 21.8% inerts (7.0% + 14.8% = 21.8%) and results in an as received heating value of 10,800 BTU/lb. The higher moisture results because of the higher surface moisture obtained when processing the under 1/4 inch x 0 size fraction. The full washing scheme results in a lower ash product because high ash material in the 1/4 inch x 0 size fraction is removed from the 1/4 inch x 100 mesh material in Water-Only cyclones and poor quality

*All analyses are as received.

100 mesh x 0 fraction is discarded as refuse. The discarded 100 mesh x 0 fraction amounts to approximately 5% of the raw coal feed and has an ash content of approximately 25.6%.

The range in ash and moisture associated with the clean coal product allows for fluctuations in the raw coal feed screen analysis and percent ash that would normally be expected in underground mining operations.

2. Range of Clean Coal Quality

The ranges of coal quality tabulated in the Draft EIS are simply the worst and best drill core values from the original Bechtel report on geology, coal quality and reserves. These values are in no way representative of the expected range of quality for either raw or clean coal. The original Bechtel data was utilized in establishing the updated Kaiser Engineers recommended ranges using the following methods:

1. A judgment was made as to which seams would be mined and only analysis pertaining to those seams was included in the analysis.

2. Although high ash material will enter the preparation plant in the raw coal feed, the maximum coal product produced by the preparation plant is less than 9.0%. Since the maximum ash product produced by the preparation plant is 9.0%, all core data with higher than 10.0% ash was not included in the analysis. For example, if an ultimate analysis showed 20.0% ash, all other values could only add to 80.0%, whereas based on the preparation plant design the values other than ash must add to 91.0%. Therefore, including core analysis with greater than 10.0% ash for frequency distribution of clean coal quality would not be valid.

3. The data remaining after steps one and two were plotted as frequency histograms.

4. A judgment was made as to what range limits would be expected from the clean coal quality, including ash and sulfur content, based on the shape of the frequency histogram. Considerable blending will occur since the coal is mined from 36 different mining sections in four separate mines. Blending results in narrowing the range of some characteristics of the coal, such as sulfur content. If the quality histogram was relatively flat, a wide range was specified for clean coal quality, and if the histogram peaked near the average value, a narrower range was specified.

Tests have indicated that the Kaiparowits coal field has a relatively uniform quality both laterally within each seam and from seam to seam. However, quality variations will exist across the coal field. For example, as reported in the Kaiparowits Draft EIS, testing has shown that raw coal with a sulfur content of up to 1.43 percent does exist in the Kaiparowits coal field. Considerable blending occurs since the coal is mined from 36 different mining sections in four separate mines. When mined this higher sulfur coal would be blended with lower sulfur coal so that the sulfur content of the resultant blend would fall within the 0.35-0.75 percent range.

No sulfur reduction was assumed to occur in the original partial wash coal cleaning process. Recent sulfur forms tests indicate that approximately 20% of the sulfur contained in the Kaiparowits coal is pyritic sulfur resulting in approximately 0.1% sulfur reduction in the product of a full washing scheme. This fact and the effect of blending coal from 36 mining sections in four separate mines has resulted in reducing the results of the clean coal quality analysis in regard to sulfur content range and average (0.52% to 0.42%).

APPENDIX II-1

Percentage Frequency of Wind Speed and Direction of Morning and Afternoon Winds

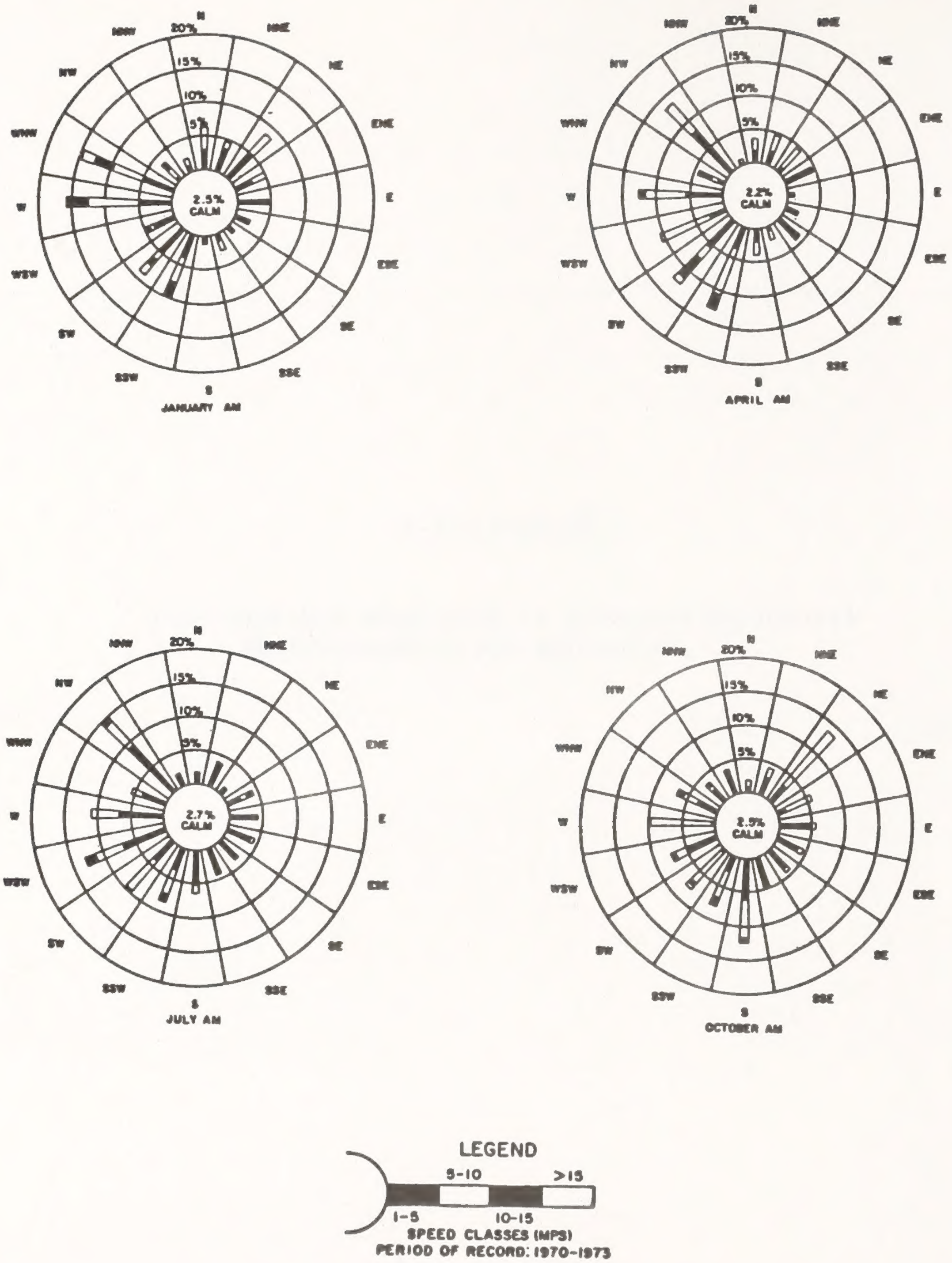


ILLUSTRATION 1

Percentage Frequency of Wind Speed and
Direction of Morning Winds at 7,300 Feet
MSL Over Page, Arizona

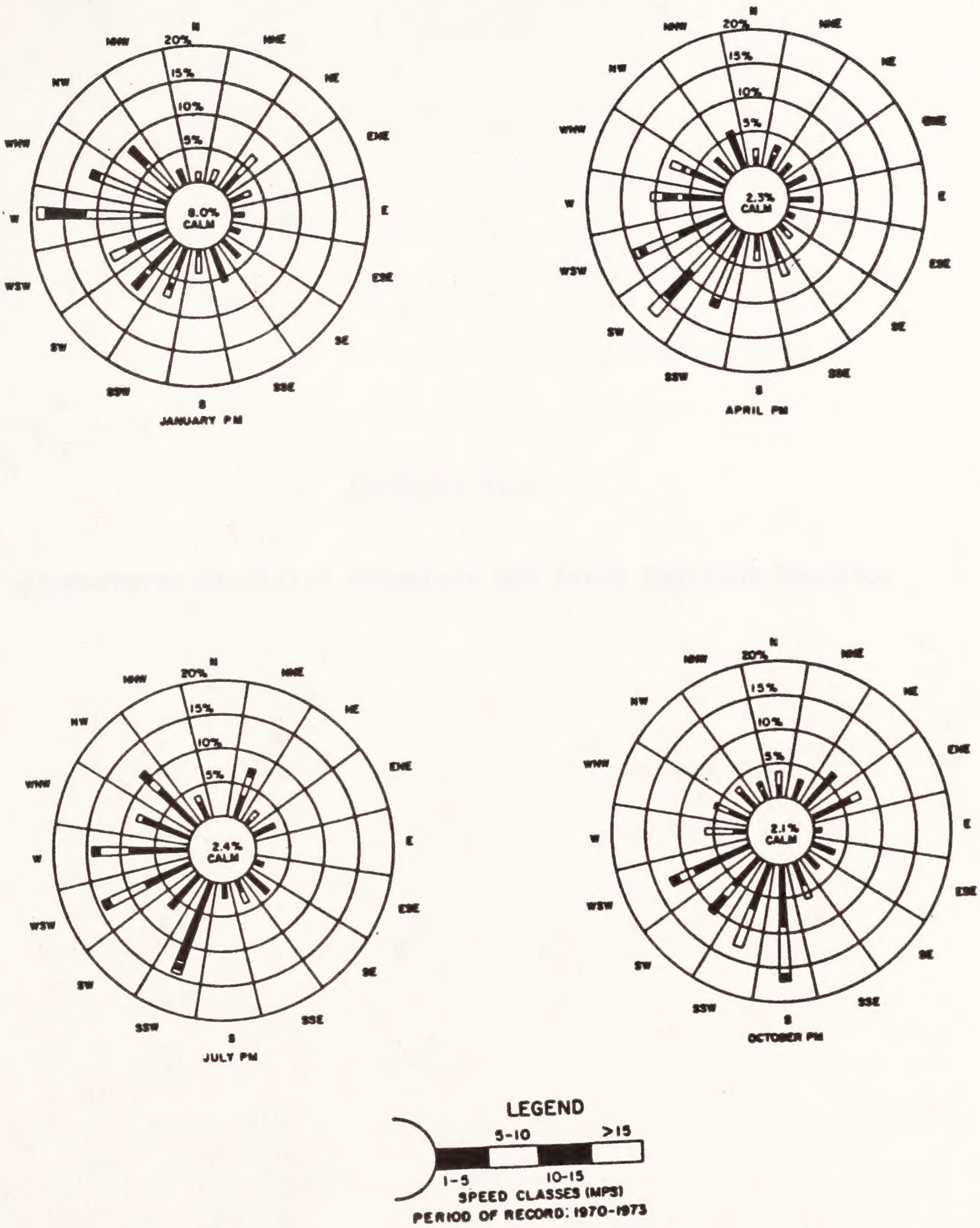


ILLUSTRATION 2

Percentage Frequency of Wind Speed
and Direction of Afternoon Winds
at 7,300 MSL Over Page, Arizona

APPENDIX II-2

Atmospheric Stability Structure and Stack Emission Behavior

APPENDIX II-2

Air Quality

Atmospheric stability structure and stack emission behavior

Changes in air temperature with height define the stability of the atmosphere (whether vertical air motions are subdued or amplified). If the air temperature increases with height (termed a temperature inversion), or if it decreases less than the adiabatic lapse rate (defined as a temperature decrease of 1° centigrade per 100 meters), the atmosphere is stable and plume rise and dispersion of emissions is restricted. Stable conditions generally occur with clear skies and light winds at night as a result of radiational cooling. Nighttime conditions are usually characterized by formation of a low-level temperature inversion layer from nocturnal cooling of the earth's surface. The base of the stable layer can be at ground level or at varying elevations above ground. Daytime conditions are characterized by air temperature decreasing with height because of ground-surface heating. During cloudy, windy day or windy night conditions the temperature lapse rate is nearly adiabatic, and the atmosphere is defined as neutrally stable. On a clear summer day, rapid heating of the earth can warm the air near the surface to where the decrease in air temperature with height is greater than the normal adiabatic lapse rate, (superadiabatic). Under these conditions the atmosphere is defined as unstable; marked vertical mixing of air results, and pollutants are dispersed rapidly.

The shape or configuration of a stack plume is largely dependent upon temperature and wind structure influencing the plume. Of primary importance in determining plume behavior, and consequently its effect at ground level, are the relative heights of the stack plume and the base of an influencing stable air layer. Illustration 1 provides an idealized representation of plume behavior under stable, neutral, and unstable atmospheric conditions as well as inversion breakup and limited mixing conditions.

Briggs (1969) has identified and described the typical behavior of smoke plumes associated with diurnal heating effects.

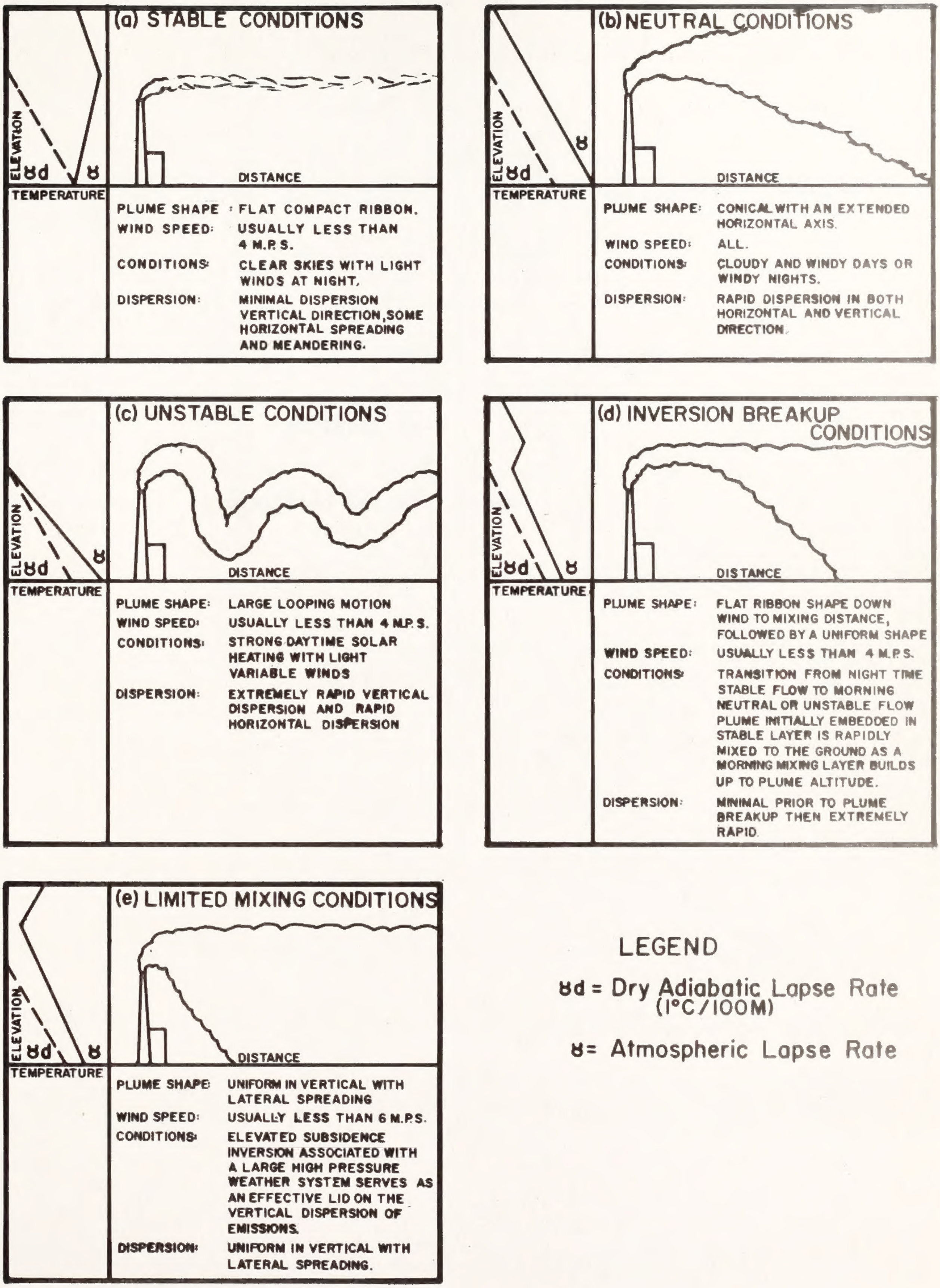
An inversion is formed on clear nights when the ground radiates heat and surface air is cooled. This stable layer may be one or two thousand meters deep, so plumes rising through it rapidly reach equivalent buoyancy level. This is the fanning type plume characteristic of clear skies and light winds at night or in early morning.

After sunrise the ground warms and temperature increase associated with height then changes to a decrease with height to remove the surface inversion (burnoff). Convective eddies develop and penetrate higher as daytime ground heating progresses. When the eddies reach the height of the plume, they rapidly mix the plume toward the ground while the inversion aloft prevents upward diffusion. This inversion breakup condition, called fumigation, can bring relatively large concentrations of effluent to ground level.

After an inversion has been destroyed by convection, or during cloudy and windy days or windy nights, the atmosphere is well mixed and has essentially neutral stability. Plumes then rise and diffuse in a smooth fashion known as coning.

Later in the day when heating at the ground intensifies, the lapse rate becomes unstable and large convective eddies form to twist and fragment the plume in a manner described as looping. Short periods of relatively high concentrations are experienced whenever the looping plume reaches the ground.

Near sunset, convection diminishes and a ground-based radiation inversion begins to form again. The plume can penetrate this weak inversion, but cannot diffuse downward because of the underlying stable conditions. This condition called lofting, is the most ideal for releasing effluents since the effluents are least likely to reach the ground. The limited mixing condition consists of an elevated inversion with a neutral or well mixed layer below. The inversion generally acts as a lid to effectively reduce vertical dispersion of emissions. The emissions are trapped within the mixing volume as determined by height of the inversion base and surrounding terrain.



(a) STABLE CONDITIONS

PLUME SHAPE:	FLAT COMPACT RIBBON.
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	CLEAR SKIES WITH LIGHT WINDS AT NIGHT.
DISPERSION:	MINIMAL DISPERSION VERTICAL DIRECTION, SOME HORIZONTAL SPREADING AND MEANDERING.

(b) NEUTRAL CONDITIONS

PLUME SHAPE:	CONICAL WITH AN EXTENDED HORIZONTAL AXIS.
WIND SPEED:	ALL.
CONDITIONS:	CLOUDY AND WINDY DAYS OR WINDY NIGHTS.
DISPERSION:	RAPID DISPERSION IN BOTH HORIZONTAL AND VERTICAL DIRECTION.

(c) UNSTABLE CONDITIONS

PLUME SHAPE:	LARGE LOOPING MOTION
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	STRONG DAYTIME SOLAR HEATING WITH LIGHT VARIABLE WINDS
DISPERSION:	EXTREMELY RAPID VERTICAL DISPERSION AND RAPID HORIZONTAL DISPERSION

(d) INVERSION BREAKUP CONDITIONS

PLUME SHAPE:	FLAT RIBBON SHAPE DOWN WIND TO MIXING DISTANCE, FOLLOWED BY A UNIFORM SHAPE
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	TRANSITION FROM NIGHT TIME STABLE FLOW TO MORNING NEUTRAL OR UNSTABLE FLOW PLUME INITIALLY EMBEDDED IN STABLE LAYER IS RAPIDLY MIXED TO THE GROUND AS A MORNING MIXING LAYER BUILDS UP TO PLUME ALTITUDE.
DISPERSION:	MINIMAL PRIOR TO PLUME BREAKUP THEN EXTREMELY RAPID.

(e) LIMITED MIXING CONDITIONS

PLUME SHAPE:	UNIFORM IN VERTICAL WITH LATERAL SPREADING
WIND SPEED:	USUALLY LESS THAN 6 M.P.S.
CONDITIONS:	ELEVATED SUBSIDENCE INVERSION ASSOCIATED WITH A LARGE HIGH PRESSURE WEATHER SYSTEM SERVES AS AN EFFECTIVE LID ON THE VERTICAL DISPERSION OF EMISSIONS.
DISPERSION:	UNIFORM IN VERTICAL WITH LATERAL SPREADING.

LEGEND

γd = Dry Adiabatic Lapse Rate (1°C/100M)

γ = Atmospheric Lapse Rate

ILLUSTRATION 1

Idealized Dispersion Patterns From a Tall Stack Under Varying Atmospheric Conditions

APPENDIX II-3

Modified Mercalli Scale

APPENDIX II-3

Geology and Topography

Generating Station and Mine Impact Area

Modified Mercalli Intensity Scale of 1931 (Abridged)

I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale,)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to III Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing truck. Duration estimted. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plater; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motorcars. (VIII - Rossi-Forel Scale.)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX + Rossi-Forel Scale.)

X. Some well-built wooden structures destroyed; mostly masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

APPENDIX II-4

Soil Interpretations Data

APPENDIX II-4

Soils

Kaiparowits Plateau impact area

Soils interpretation data

Methodology for soils interpretations

1. Soils data developed from watershed inventories and soil association information are presented in Illustration 1 this section.

2. Existing erosion conditions were determined by evaluating soil movement, surface litter, surface rock, pedestalling of plants and surface rock, flow patterns on the soil surface and the magnitude and frequency of rills and gullies.

3. Effective root depth (ERD) is the depth of soil material which supports most plant growth. This depth is obtained by measuring from the soil surface to a limiting layer or where the abundance of roots changes from many to few.

4. Soil texture is determined from samples taken between a depth of one-quarter to four inches, and between four inches and the effective root depth. Soil texture is divided into five broad categories: coarse textured, moderately coarse textured, medium textured, moderately fine textured. Figure 1 lists the soil classes within each broad texture category and the appropriate Soil Conservation Service symbol.

5. Slope is presented in percent and represents the whole area. Slope was one of the prime criteria used for making engineering interpretations. Figure 2 delineated the slope classes and standard descriptions.

6. Estimated sediment yield was obtained by considering surface geology, soils, storm frequency and intensity, runoff, topography, ground cover, past and present land use, upland erosion, channel erosion and sediment transport. The procedure used had been developed by the Pacific Southwest Interagency Committee (Shown, 1970).

Figure 1

Soil Class

1. Coarse Textured Soils
    a. Very Coarse Sand (vcos)
    b. Coarse Sand (cos)
    c. Sand (s)
    d. Fine Sand (fs)
    e. Very Fine Sand (vfs)
    f. Loamy Coarse Sand (lcos)
    g. Loamy Sand (ls)
2. Moderately Coarse Textured Soils
    a. Loamy Fine Sand (lfs)
    b. Sandy Loam (sl)
    c. Fine Sandy Loam (fsl)
3. Medium Textured Soils
    a. Very Fine Sandy Loam (vfsl)
    b. Loam (l)
    c. Silt Loam (sil)
    d. Silt (si)
4. Moderately Fine Textured Soils
    a. Clay Loam (cl)
    b. Sandy Clay Loam (scl)
    c. Silty Clay Loam (sicl)
5. Fine Textured Soils
    a. Sandy Clay (sc)
    b. Silty Clay (sic)
    c. Clay (c)

Figure 2

Slope Class Descriptions

Percent Slope	Simple Slope	Complex Slopes
Less than 1	Nearly Flat	---------------
1-3	Nearly Level	Gently Undulating
3-8	Gently Sloping	Undulating
8-15	Sloping	Gently Rolling
15-30	Moderately Steep	Rolling
30-45	Steep	Steep
Greater than 45	Very Steep	Very Steep

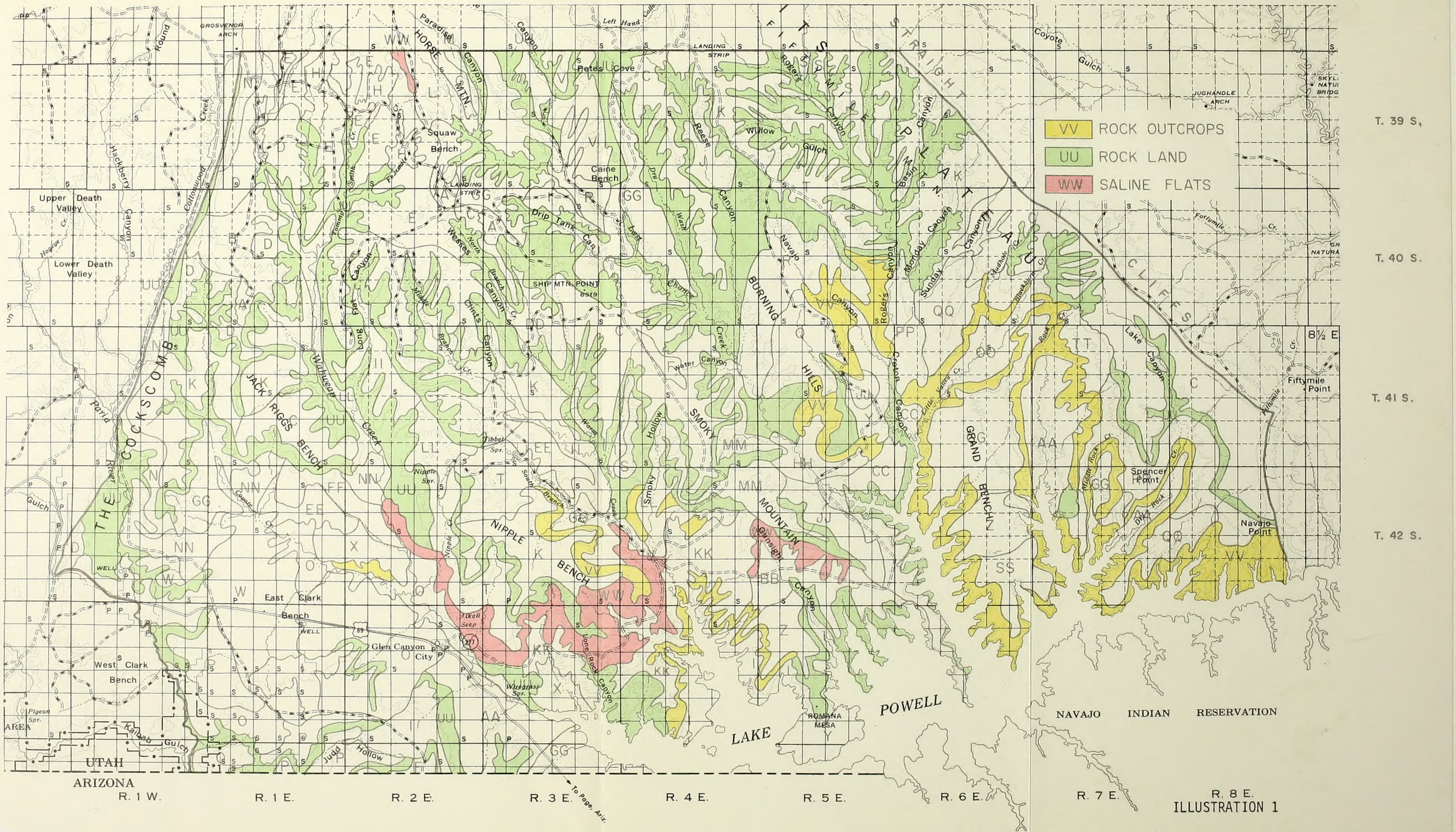


ILLUSTRATION 1

Soils - Keyed to Figure 3

7. The percent probability of success for reseeding was developed by adapting watershed inventory data and known soils data to the soil suitability guide designed by the Bureau of Land Management (Hagihara, et al, 1972).

8. The erosion susceptibility formula was developed by considering slope, parent and bed material, and soil texture. Slight erosion susceptibility pertains to slopes less than 15 percent, comprised of consolidated material such as igneous or crystalline rock and a soil texture generally coarse to moderately coarse. Moderate erosion susceptibility pertains to slopes between 15 to 30 percent, comprised of alluvium or unconsolidated material and generally medium soil texture. Severe erosion susceptibility pertains to slopes in excess of 30 percent and soil textures generally moderately fine to fine.

9. The hydrologic soil group is based on soil depth and infiltration rates in inches per hour. Generally, hydrologic group A has an infiltration rate in excess of 3.5 inches per hour; hydrologic group B, 2.0 to 3.5 inches per hour; hydrologic group C, 0.5 to 2.0 inches per hour, and hydrologic group D, less than 0.5 of an inch per hour.

Discussion of soils limitation ratings

All soil limitation ratings presented in Figure 3 are based on criteria developed by the Soil Conservation Service (SCS, 1971). The information is not intended to be specific enough for detailed design of engineering installations but is specific enough to make a general evaluation of limitation or suitability for selected uses.

Soil limitation ratings are expressed in three phases, which are described as follows:

Slight soil limitation indicates properties favorable for rated use. The degree of limitation is minor and can be easily overcome. good performance and low maintenance can be expected.

Moderate soil limitation indicates properties moderately favorable for rated use. This degree of limitation can be overcome or modified by special planning, design or maintenance.

Severe soil limitation indicates one or more properties unfavorable for rated use. This degree of limitation generally requires major soil reclamation, special design, or intensive maintenance. Some of these soils can be improved by reducing or removing the soil feature that limits use, but, in most situations, it is both difficult and costly to alter the soil or to design a structure to compensate for a severe degree of limitation.

Explanation of ratings

1. Limitation ratings for spetic tank abosrption fields were based on amount of slope, percolation rate and flood hazard, if known. Notations were also made where pollution became a hazard.

2. Limitation ratings for sewage lagoons were based on the same criteria as septic tank absorption fields. In the case of sewage lagoons, however, high percolation rates were considered a liability and not an asset. Pollution hazard areas were also noted.

3. Limitation ratings for shallow excavations were based on slope, flood hazard, resistance to sloughing, workability, and absence of rocks.

4. Limitation ratings for dwellings were based on slope, flooding potential, presence of expansive clays, rockiness, and depth to bedrock.

5. Limitation ratings for trench-type sanitary landfills were based on amount of slope, permeability, drainage, depth to bedrock, and flooding. Areas with pollution hazard were also noted.

6. Limitation ratings for area-type sanitary landfills used the same criteria as those for trench-type sanitary landfills. However, gentler slopes

were required for area-type sanitary landfills rather than trench-type sanitary landfills. Notations were also made for areas that could be a pollution hazard.

7. Limitation ratings for soils as sources of cover material for area-type sanitary landfills were based on slope, depth, and stoniness.

8. Limitation ratings for local roads and streets were based on slope, frequency of flooding, presence of gypsum and presence of expansive clays.

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau impact area

GENERAL DATA												Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi²	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
A	2,690	Moderate	16"+	Moderate-coarse	Medium	3-8	0.4-0.5	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
B	6,080	Slight	16"+	Medium	Medium	1-3	0.3-0.4	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to high Perm.	Slight	Slight	Slight	Slight	Slight	Slight
C	47,340	Moderate	12"-15"	Moderate-Coarse	Moderate-Coarse	3-8	0.4-0.5	30-50 due to water holding capacity	Slight	B	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
D	15,000	Moderate	12"-15"	Moderate-Coarse	Medium	8-15	0.55-0.65	30-50 due to low rainfall	Moderate	B	Mod, due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Moderate due to slope
E	14,560	Moderate	12"-15"	Medium	Mod.-Fine	3-8	0.45-0.55	30-50 due to low rainfall	Mod.	C	Mod. due to low Perm.	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
F	1,800	Slight	12'-15'	Medium	Medium	1-3	0.35-0.45	< 30% due to low rainfall	Mod.	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
G	530	Moderate	12"-15"	Moderate-Fine	Moderate-Fine	3-8	0.5-0.6	30-50 due to rainfall	Mod.	C	Mod. due to low perm.	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
H	6,160	Moderate	12"-15"	Moderate-Fine	Fine	1-3	0.4-0.5	30-50 due to low rainfall	Moderate	D	Severe due to low perm. & rare flooding	Moderate due to rare flooding	Severe due to rare flooding	Severe due to rare flooding	Moderate due to rare flooding	Moderate due to rare flooding	Slight	Moderate due to rare flooding

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA				TEXTURE							Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	¼-4 inches	4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
I	**25,315**	**Slight-Moderate**	**10"-11"**	**Moderate Coarse**	**Medium**	3-8	0.4-0.5	< 30 due to low Rainfall	Moderate	B	Slight-Pollution Hazard Near Res.	Moderate due to slope & Flooding Near Res.	Slight Mod near Res. due to Flooding	Slight severe Near Res. due to Flooding	Slight severe Near Res. due to Flooding	Slight Mod near Res. due to Flooding	Slight	Slight Mod near Res. due to Flooding
J	**3,040**	**Moderate**	**10"-11"**	**Moderate Coarse**	**Medium**	8-15	0.45-0.55	30-50 due to low Rainfall	Moderate	B	Moderate due to Slope	Moderate due to Slope	Moderate due to Slope	Moderate due to Slope	Slight	Moderate due to Slope	Moderate due to Slope	Moderate due to slope
K	**47,100**	**Moderate**	**10"-11"**	**Medium**	**Medium**	3-8	0.4-0.5	30-50 due to low Rainfall	Moderate	B	Slight	Moderate due to slope	Slight	Slight	Slight	Slight	Slight	Slight
L	**7,600**	**Critical**	**10"-11"**	**Moderate Fine**	**Moderate Fine**	8-15	0.45-0.55	30-50 due to low Rainfall	Moderate	C	Moderate due to slope	Moderate due to slope	Moderate due to slope	Moderate due to slope	Slight	Moderate due to slope	Moderate due to slope	Moderate due to slope
M	**1,180**	**Moderate**	**4"-9"**	**Moderate Coarse**	**Medium**	15-30	0.55-0.65	< 30 due to Shallow Depth	Moderate	B	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
N	**4,070**	**Moderate**	**4"-9"**	**Medium**	**Medium**	15-30	0.6-0.7	< 30 due to slope	Moderate	B	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to Slope	Severe due to slope
O	**23,970**	**Severe**	**12"-15"**	**Moderate Coarse**	**Moderate Coarse**	8-15	0.6-0.7	30-50 due to low Rainfall	Moderate	C	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Slight	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	**Moderate due to slope & Gypsum Present**
P	**8,660**	**Moderate**	**10"-11"**	**Moderate Coarse**	Moderate Coarse	1-3	0.35-0.45	< 30 due to low Rainfall	Slight	C	Slight	Moderate due to slope & Gypsum Present	Slight except where Gypsum Present	Slight	Slight	Slight	Slight	**Slight except where Gypsum Present**

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA				TEXTURE							Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	¼-4 inches	4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
Q	5,050	Critical	10"-11"	Moderate-Coarse	Mod.-Coarse	15-30	0.45-0.55	< 30 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
R	11,770	Moderate	10"-11"	Mod.-Coarse	Medium	15-30	0.5-0.6	< 30 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
S	17,440	Moderate	10"-11"	Medium	Medium	8-15	0.45-0.55	30-50 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
T	15,460	Moderate	4"- 9"	Medium	Medium	3-8	0.5-0.6	< 30 due to low productivity potential	Moderate	C	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
U	1,560	Critical	10"-11"	Medium	Mod.-Fine	30-45	0.6-0.7	< 30 due to steep slope	Severe	D	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
V	6,120	Critical	4"- 9"	Medium	Mod. - Fine	15-30	0.9-1.0	< 30 due to steep slope	Severe	D	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
W	26,110	Slight	16" +	Mod.-Coarse	Medium	1-3	0.3-0.4	30-50 due to low rainfall	Moderate	A	Slight	Slight Mod. when gypsum pres.	Slight	Slight Severe where gypsum pres.	Slight	Slight	Slight	Slight Severe where gypsum pres.
X	4,980	Moderate	16" +	Coarse	Mod. - Coarse	3-8	0.4-0.5	30-50 due to low rainfall	Moderate	A	Slight pollution haz. near res.	Mod. due to slope pollution haz.	Slight	Slight	Slight pollution haz. near res.	Slight pollution haz. near res.	Slight	Slight

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

		GENERAL DATA										Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep- tibility	Hydro- logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwellings	Trench- type Sanitary Landfill	Area- type Sanitary Landfill	Cover Material for Area- type Sanitary Landfill	Local Roads & Streets
Y	6,840	Slight	12"-15"	Coarse	Mod. - Coarse	3-8	0.3-0.4	< 30 due to low rainfall	Slight	B	Slight Pollution haz. near res.	Mod. due to slope	Slight	Slight Mod. when gypsum pres.	Slight	Slight	Slight	Slight- Mod. where gypsum pres.
Z	6,460	Moderate	12"-15"	Mod. - Coarse	Mod. - Coarse	1-3	0.3-0.4	< 30 due to low rainfall	Slight	B	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
AA	16,970	Moderate	4"-9"	Mod. - Coarse	Mod. - Coarse	3-8	0.35-0.45	< 30 due to low rainfall	Slight	B	Mod.- rare flooding poll. haz near res.	Mod. due to slope	Mod. rare flooding	Severe rare flooding	Mod.- rare flooding Pollution hazard near res.	Mod. rare flooding pollution hazard near res.	Slight	Mod. rare flooding
BB	5,890	Moderate	4"-9"	Mod. - Coarse	Medium	1-3	0.35-0.45	< 30 due to low rainfall	Slight	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Sligh	Slight	Slight
CC	10,440	Moderate	4"-9"	Medium	Medium	1-3	0.35-0.45	< 30 due to low rainfall	Moderate	B	Slight poll. haz. near res.	Mod. due to high perm.	Slight	Slight	Slight poll. haz. near res.	Slight poll. haz. near res.	Slight	Slight
DD	3,570	Moderate	4"-9"	Mod. - Coarse	Medium	8-15	0.45-0.55	< 30 due to low rainfall	Moderate	B	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
EE	4,710	Severe	4"-9"	Medium	Mod. - Fine	3-8	0.9-1.0	< 30 due to low rainfall	Moderate	C	Mod. due to low perm.	Mod. due to slope	Slight	Severe due to expansive clays	Severe due to expansive clays	Slight	Severe due to expans. clays	severe due to expans. clays

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA											Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
FF	3,430	Moderate	10"-11"	Medium	Medium	1-3	0.35-0.45	30-50 due to low rainfall	Moderate	B	Slight	Moderate due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
GG	52,860	Moderate	4"-9"	Medium	Medium	8-15	0.55-0.65	<30% due to low rainfall	Moderate	B	Mod due to slope Poll Haz near res.	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope
HH	2,580	Moderate	10"-11"	Medium	Mod.-Coarse	1-3	0.35-0.45	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
II	8,390	Moderate	4"-9"	Medium	Mod.-Fine	8-15	0.8-0.9	< 30 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
JJ	4,400	Critical	4"-9"	Mod. - Fine	Medium	15-30%	0.9-1.0	< 30 due to low rainfall	Severe	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope
KK	12,500	Slight	4"-9"	Mod.-Fine	Mod.-Fine	3-8	0.6-0.7	<30 due to low rainfall	Moderate	C	Mod due to low perm. Poll. haz. near res.	Mod. due to slope	Slight Expans.	Severe Expans. clays	Severe Expans. clays	Slight	Severe Expans. clays	Severe Expans. clays
LL	10,710	Slight	4"-9"	Mod.-Fine	Mod. - Fine	8-15	0.7-0.8	<30 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
MM	5,130	Slight	4"-9"	Mod. - Fine	Mod. - Fine	15-30	0.75-0.85	<30 due to low rainfall & slope	Severe	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA											Soil Limitation Ratings							
				TEXTURE														
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	¼-4 inches	4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
NN	7,100	Critical	4"-9"	Fine	Fine	3-8	0.9-1.0	< 30 due to low rainfall	Moderate	D	Severe due to low perm.	Mod. due to slope	Slight	Severe Expans. clays	Severe Expans. clays	Slight	Severe Expans. clays	Severe Expans. Clays
OO	6,400	Moderate	12"-15"	Medium	Mod.- Fine	1-3	0.5-0.6	< 30 due to low rainfall	Moderate	C	Mod. due to low perm.	Slight	Slight	Slight- except where gypsum	Slight	Slight	Slight -	Slight except where gypsum
PP	3,150	Critical	10"-11"	Medium	Medium	15-30	0.7-0.8	30-50 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope
QQ	8,470	Critical	10"-11"	Medium	Mod. - Fine	8-15	0.45-0.55	30-50 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	mod. due to slope	slight	mod. due to slope	mod. due to slope	Mod. due to slope
RR	12,830	Mod. 0 Critical	10"-11:	Medium	Mod. - Fine	15-30	0.6-0.7	30-50 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
SS	2,810	Mod. - Critical	4"-9"	Mod. - Coarse	Mod. - Coarse	1-3	0.3-0.4	< 30 due to low rainfall	Slight	C	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
TT	2,390	Critical	4"-9"	Mod. - Coarse	Mod. - Coarse	8-15	0.4-0.5	< 30 due to low rainfall	Slight	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA												Soil Limitation Ratings						
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
UU (Steep & Rocky)	163,000	Critical	4"-9"	--	--	35-65	1.0-1.5	--	Severe	D	<		Severe due to steep slopes and high amounts of rock					>
VV Rock outcrops	28,800	--	--	--	--	--	--	--	--	D	<		Severe due to lack of permiability and being solid rock					>
WW Saline Flats	12,800	--	--	--	---	--	--	--	--	D	<		Severe due to poor drainage and presence of expansive clays					>
TOTAL	705,525																	

APPENDIX II-5

Technical Description of Soil Associations

APPENDIX II-5

Soils

Kaiparowits Plateau impact area

Technical description of soil associations (Wilson, et al., 1975)

Deep Plateau Soils Association

Soils mapped by symbols "A" through "N" belong to the Ustic Torrifluvents-Ustic Torriorhents Soil Association. This association consists of about 70 percent Ustic Torrifluvents, 20 percent Ustic Torriorthents and 10 percent Ustollic Camborthids and Ustollic Calciorhids. (See Glossary in Appendix for definitions of soils names and terminology.)

Ustic Torrifluvents are deep, mildly and moderately alkaline soils. Surface layers are light brownish-gray, light-brown, light reddish-brown and reddish-brown fine sandy loams, loams, silt loams and silty clay loams. Subsoils are light reddish-brown, light grayish-brown and pinkish-gray fine, fine silty, fine loamy and coarse loamy. Substrata are light reddish-brown, light brownish-gray and pinkish-gray fine, fine silty, fine loamy and coarse loamy.

Ustic Torriorthents are deep, mildly and moderately alkaline soils. Surface layers are light brownish-gray, light-brown, light reddish-brown and reddish-brown, fine sandy loams and silty clay loams. Subsoils are light reddish-brown, light grayish-brown and pinkish-gray fine loamy, fine silty and coarse loamy. Substrata are light reddish-brown, light brownish-gray and pinkish-gray fine loamy, fine silty, coarse loamy and loamy skeletal.

Soils in this association are well and moderately well drained. Permeability is slow to moderately rapid. Runoff is slow to medium and sediment production is moderate to high. Hydrologic groups are mainly B and C.

Shallow Plateau Soils Assocation

Soils mapped by symbols "O" through "T" belong to the Lithic Ustollic Calciorthids - Lithic Ustic Torriorthents Soil Association. This association consists of about 35 percent Lithic Ustollic Calciorthids, 20 percent Lithic Ustic Torriorthents, 20 percent Ustollic Calciorthids, 15 percent Ustollic Haplargids and 10 percent Ustic Torriorthents.

Lithic Ustollic Calciorthids are shallow, mildly and moderately alkaline soils. Surface layers are reddish-brown, angular, very cobbly, fine sandy loam. Subsoils are reddish-brown and pink-loamy skeletal, underlain by fractured bedrock at depths of 10 to 20 inches.

Lithic Ustic Torriorthents are shallow, mildly and moderately alkaline soils. Surface layers are brown and reddish-brown, very gravelly loams. Subsoils are pale-brown loam skeletal, underlain by bedrock at depths of 10 to 20 inches.

Ustollic Calciorthids are moderately deep and deep, mildly and moderately alkaline soils. Surface layers are yellowish-red and reddish-brown very fine sandy loams. Subsoils are red and yellowish-red fine loamy and coarse loamy. Calcium carbonate layers occur between depths of six to 18 inches.

Ustollic Haplargids are deep and moderately deep, mildly and strongly alkaline soils. Surface layers are light brown, very pale brown, and reddish-brown fine loamy and loamy skeletal. Substrata are very pale brown, light gray and pinkish-gray, fine loamy, loamy skeletal and sandy or sandy skeletal. Calcium carbonate layers occur between depths of 12 to 24 inches.

Soils in this association are well drained. Permeability is moderate to rapid. Runoff is medium to rapid and sediment production is moderate to low. Hydrologic groups are mainly C for the Ustollic Calciorthids and Lithic Ustic Torriorthents.

Shallow Soil-Rock Outcrop Soil Association

Soils mapped by symbols "U" and "V" belong to the Ustic Torriorthents Shallow Soil-Rock Outcrop Soil Association. This association consists of about 60 percent Ustic Torriorthents (shallow), 15 percent Rock Outcrop and 25 percent Typic Ustorthents and Typic Haploborolls.

Ustic Torriorthents (shallow) are mainly shallow but some are moderately deep, mildly to moderately alkaline soils. Surface layers are light brownish-gray and light yellowish-brown loams, silt loams, and silty clay loams. Subsoils are pale brown, light grayish-brown and brownish-gray, loamy and clayey. Underlying shale and interbedded sandstone occur mainly within a depth of 20 inches.

Soils in this association are well drained. Permeability is moderate to very slow. Runoff is moderate to high and sediment production is high. The hydrologic group mainly D.

Sandy Soil Association

Symbol "W" represents Sandy Soil Association and belongs to the Typic Torripsamments - Typic Torriorthents Soil Association. This association consists of 60 percent Typic Torripsamments, 20 percent Typic Torriorthents and 20 percent mainly Lithic Calciorthids and Typic Calciorthids.

Typic Torripsamments are deep, mildly to moderately alkaline soils. Surface layers are yellowish-red loamy fine sands. Subsoils are yellowish-red and sandy. Substrata are yellowish-red and sandy.

Soils in this association are excessively drained. Permeability is rapid. Runoff is slow to medium and sediment production is low. The hydrologic group is mainly A.

Badland-Rockland Association

Soils mapped by symbols "X" through "WW" belong to the Badland-Rockland Assocation. Bare rock outcrops cover approximately 30 to 50 percent of the area. Shallow and very shallow soils over sandstone bedrock comprise about 20 to 40 percent. About five to 10 percent is deep and moderately deep soils.

Runoff is high and resultant heavy sediment production is a major problem in these areas.

APPENDIX II-6

Soils Associations, Groups and Interpretations-Transmission System

APPENDIX II-6

Soils

Soils associations groups and interpretations - transmission system

Soil association descriptions for Arizona and Nevada:

Unit 1 - Anthony-Vinton-Aqua Soil Association.

This unit consists of deep soils on alluvial fans and low terraces. Slopes range from zero to five percent. The unit is made up of 35 percent Anthony, 30 percent Vinton, 20 percent Aqua, and 15 percent consists of intermixed areas of Gila, Glendale, Cave, and Rillino soils. The Anthony, Vinton, and Aqua soils range from sandy loams to loams and are deep (over 60 inches). The three soils have moderately rapid permeability, moderate to low water-holding capacities, and are in hydrologic group B (moderately slow runoff). Revegetation would be difficult due to low water-holding capacity and low annual precipitation.

Unit 1A - Cabezon-Springerville-Thunderbird Soil Association.

These soils are shallow to moderately deep and on slopes from zero to 30 percent. They are developed on basaltic formations. The Cabezon soils are shallow, cobbly, or stony loam or clay loam over fractured basalt bedrock. The Springerville and Thunderbird soils are moderately deep, gravelly on cobbly clays to clay loams. These soils are in hydrologic group D with rapid runoff. This soil association is in the slight to low moderate erosion condition classes. On lower slopes the soils have a very slight erosion hazard and on the higher slopes the erosion hazard is moderate. The estimated sediment yield is less than .2 acre-feet per square mile per year. These soils can be revegetated using good conservation methods.

Unit 1B - Sizer-Rudd-Bandera Soil Association

The soils are gravelly or cindery loamy, formed on cinders or basalt. Sizer and Rudd soils make up 35 percent each of the unit and Bandera soils, 20 percent. Ten percent is alluvial soils in drainage ways and washes. Sizer soils are gravelly silt loam over cinders or very cindery coarse-textured material. These soils are found on sides and bases of cinder cones with slopes of five to 30 percent. The Rudd soils are gravelly to very gravelly loams that are strongly calcarcous over fractured bedrock. They are on basaltic plateaus or plains with slopes of zero to five percent. The Bandera soils are very similar to Sizer but are more cindery throughout and have slopes from five to 45 percent. The unit's soils have a moderate to high available water capacity and moderately slow to moderately high permeability. The Sizer and Bandera soils are in hydrologic group B, well drained soils with moderate infiltration rates; Rudd soils are in hydrologic group D, with rapid runoff. The erosion condition is slight to moderate and the erosion susceptibility is slight in most areas and moderate on slopes greater than 30 percent. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils can be revegetated with extreme care. They are coarse textured with a moderate to low water-holding capacity.

Unit 1D - Brolliar-Sponseller Soil Association.

The soils are moderately deep over basaltic or cindery materials. Brolliar soils make up 60 percent and Sponseller soils 30 percent; the remaining 10 percent is made up of rock outcrops and alluvial soils in drainages and small basins. Brolliar soils are cobbly or stony loams with clay loam to clay subsoils. Sponseller soils are very similar to the Brolliar except for color. Sponseller soils are reddish-brown and Brolliar soils are dark colored. Slopes range from zero to 30 percent. Brolliar soils are in hydrologic group D with rapid runoff; and Sponseller soils are in hydrologic group B with well drained soils and moderate infiltration rates. This soil association is in the slight to moderate erosion class, but when disturbed, the erosion hazard for Brolliar soils is severe on slopes over eight percent, and Sponseller soils on slopes over 30 percent. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. Both soils can be revegetated on lesser slopes with a higher percent of success than on higher slopes, using water control measures. Both soils have high water-holding capabilities and annual precipitation is about 18 to 26 inches.

Unit 2 - Cave Soil Association.

This unit consists of very shallow to shallow soils with lime hardpans on valley slopes and mesas. Slopes range from one to 30 percent. Cave soils make up 60 percent of the unit, the remaining 40 percent is made up of Winkel, Nickel, and small intermixed areas of other calcareous soils. Cave soils are shallow, gravelly, sandy loams over lime hardpans. Cave soils have very slow permeability, very low water-holding capacity, and are in hydrologic group D (rapid runoff). This association would be very difficult to revegetate.

Unit 2A - Winona-Boysag Soil Association.

This unit is made up of approximately 60 percent Winona gravelly or cobbly calcareous loams and 30 percent Boysag gravelly loams to sandy loams. Both soils are moderately shallow, underlain by fractured limestone and calcareous sandstone. The loams have moderate available water capacity, they clays have high available water capacity, moderate to slow permeability, slopes ranging from two to 15 percent with some area on the breaks up to 50 percent. Both soils are in hydrologic group D which indicate areas of rapid runoff. The erosion condition is slight to moderate and the soils have only slight to moderate erosion susceptibility when disturbed. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils would be difficult to revegetate due to shallowness to bedrock.

Unit 3 - Laveen-Corrizo-Antho Soil Association

This unit consists of deep soils on dissected terraces and alluvial fans. Slopes range from zero to eight percent but include short slopes up to 50 percent. The unit is made up of 40 percent Laveen, 25 percent Carrizo, 25 percent Antho, and 10 percent other soils and riverwash. Laveen soils are deep loams with moderate permeability, high water-holding capacity, and are in the hydrologic group B (moderately slow runoff). Corrizo soils are deep loamy, fine sands with rapid permeability, low water-holding capacity, and are in hydrologic group A (very slow runoff). Antho soils are sandy to gravelly sandy loams with moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (moderately slow runoff). This unit would be difficult to revegetate due to low annual precipitation.

Unit 3A - Showlow-Pastura-Poley Soil Association

This unit consists of soils on upland plains that range from nearly level to rolling and moderately steep in dissected areas. The soils are deep and clayey except for areas having lime hardpans at shallow depths. The unit is made up of 60 percent Showlow, 20 percent Pastura, and 10 percent Poley. The remaining 10 percent is small areas of very gravelly Lynx like soils. The Showlow soils have a deep gravelly loam surface with heavy clay loam to clay subsoils. Permeability is slow, water-holding capacity high, and in hydrologic group C (moderately rapid runoff). Pastura soils are deep calcareous loams to gravelly loams over a lime hardpan at depths ranging from seven to 20 inches. Permeability is moderate to hardpan, water-holding capacity moderate, and in hydrologic group D (rapid runoff). Poley soils are deep, gravelly loams over clayey subsoils. Permeability is slow, water-holding capacity high, and in hydrologic group C (moderately rapid runoff). Erosion susceptibility is low to moderate when disturbed. Soils in this association could be revegetated with moderate success using good conservation practices.

Unit 4 - Springerville-Cabezon Soil Association.

The soils are moderately deep to deep cobbly and/or stony soils on basaltic mountain slopes. The association is composed of 60 percent Springerville, 30 percent Cabezon, and 10 percent other related soils. Springerville soils are deep granular clays with heavy high-swelling clay subsoils over basaltic bedrock, slopes ranging from one to 10 percent but usually five percent. Cabezon soils are shallow to very shallow, cobbly or stony loams to clay loams over basaltic bedrock, slopes ranging from five to 30 percent. These soils have slow permeability and are in hydrologic group D with rapid runoff. Present erosion condition is slight to moderate and the erosion hazard is severe when disturbed. Estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. Springerville soils can be revegetated easier than Cabezon soils due to soil depth and water-holding capacity.

Unit 4A - Moenkopi - Rock Outcrop Soil Association.

This unit is made up of approximately 70 percent Moenkopi loamy sand and sandy loam, and the balance is rock outcrop and rough broken land. The soils are shallow to very shallow; they have moderate available water capacity, moderately rapid permeability, slopes ranging from two to 15 percent, and are placed in hydrologic group D, areas of rapid runoff. Erosion condition is moderate to severe and the soils are highly susceptible to wind erosion when disturbed. Estimated sediment yield is 1.0 to 3.0 acre-feet per square mile per year. These soils would be very difficult to revegetate due to low water-holding capacity and susceptibility to wind erosion.

Unit 4B - Palma-Clovis-Redbank Soil Association.

This Unit consists of deep sandy loam soils developed in alluvium from sandstone. The soils are in areas of high plains with slopes ranging from zero to 15 percent. The unit is 50 percent Palma, 30 percent Clovis, and 20 percent deep sandy loams and small areas of rough broken lands, terrace escarpments, and sandstone outcrops. Both Palma and Clovis soils have sandy loam surfaces with sandy loam to sandy clay loam subsoils. Palma soils have moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (very little runoff). Clovis soils have moderate permeability, high water-holding capacity, and are in hydrologic group B (very little runoff). When disturbed these soils would be moderately susceptible to erosion. This association would revegetate easily using good conservation practices.

Unit 4C - Sheppard Rock Outcrop Soil Association.

This unit is primarily Sheppard loamy sand with 30 percent rock outcrop. The soils are deep, low in water capacity; they have moderately rapid to rapid permeability with slopes ranging from zero to 15 percent, and are placed in hydrologic group A, areas of little runoff. Slopes range from zero to 15 percent; the erosion condition is moderate to severe. These soils are highly susceptible to wind erosion when disturbed. Estimated sediment yield is from .2 to .5 acre-feet per square mile per year. These soils would be very difficult to revegetate due to their low water-holding capability and susceptibility to wind erosion.

Unit 4D - Rillito-Gunsight-Pinal Soil Association.

This association has soils that are deep and others shallow to a lime cemented hardpan (caliche) or very gravelly loams on old alluvium. This association is composed of 35 percent Rillito, 25 percent gunsight, 20 percent Pinal, and 20 percent other related soils. Rillito soils are deep gravelly loams with a mottled lime subsoil at about 12 inches, slopes ranging from zero to five percent. Gunsight soils are deep, calcareous gravelly loams with a mottled lime subsoil and substratum at about three inches, slopes ranging from zero to 10 percent.

Pinal soils are shallow to a lime hardpan at 12 inches, slopes ranging from zero to five percent. Rillito and Gunsight soils are in hydrologic group B with moderately slow runoff and Pinal soils are in hydrologic group D with rapid runoff. Present erosion condition is slight and erosion hazard is moderate when disturbed. The estimated sediment yield is less than .2 acre-feet per square mile per year. These soils would be difficult to revegetate due to low rainfall.

Unit 5 - Latene-Rilling-Cave Soil Association

This unit consists of deep and shallow or very shallow calcareous soils on dissected old terraces. Slopes range from zero to 15 percent but up to 50 percent on short side slopes or terrace sides. This unit is made up of 30 percent Latene, 30 percent Rillino, 15 percent Cave, and 25 percent small intermixed areas of gravelly Pinaleno, Nickel, and Continental soils on the uplands, and Anthony, Gila, and Vinton soils in drainage ways. Lateno soils are deep loams over strongly calcareous loam or sandy loam with caliche gravel. Rillino soils are very similar to Latene but contain more gravel and have a higher lime content. Cave soils are shallow calcareous gravelly loams with a hard caliche layer at four to 20 inches. Latene and Rillino soils are moderately permeable and have moderate water-holding capacity; both soils are in hydrologic group B (moderate to slow runoff). Cave soils have very slow permeability and a very low water-holding capacity. Cave soils are in hydrologic group D (rapid runoff). This association would be difficult to revegetate.

Unit 5A - Sedimentary Rock Outcrop and Rough Broken Land Soil Association.

These are small areas of shallow sandy loam soils on mesa tops. These soils fall in hydrologic group D, which are areas of runoff with very slow permeability. The slope is from three to 30 percent, the erosion condition is slight, and susceptibility to wind erosion is low, due to the large percent of rock outcrop. Estimated sediment yield is less than two acre-feet per square mile per year. This unit has a very low potential for revegetation due to shallow or no soil and very low water-holding capacity.

Unit 6 - Cellar-House Mountain-Rock Outcrop Soil Association.

This unit consists of very shallow to shallow soils and rock out-crops on hills and low mountains. Slopes range from five to 60 percent, or more, on the higher, rockier peaks. This unit is made up of 35 percent Cellar soils, 25 percent House Mountain soils, 20 percent Rock Outcrop. The remaining 20 percent is Lehmans and Chiricahua soils on the lower concave slopes and saddles, and gravelly alluvial and colluvial soils on toe-slopes and in drainage ways. Cellar soils are shallow, very gravelly sandy loam. House Mountain soils are shallow, cobbly loam over cobbly clay loam subsoil. This association is in hydrologic group D (rapid runoff) and is moderately susceptible to erosion when disturbed. These soils would be very difficult to revegetate.

Unit 7 - Barkerville-Moana Soil Association.

The unit is composed of shallow and very shallow rocky soils on granite and schist. The association consists of 70 percent Barkerville; 20 percent Moano, and 10 percent related soils. Barkerville soils are very shallow gravelly or cobbly sandy loams over strongly weathered granite which becomes consolidated at 20 to 40 inches. Slopes range from 20 to 60 percent. Moanao soils are very shallow, six to 16 inches, gravelly loams over schist or phyllite bedrock which is vertically fractured, slopes ranging from two to 60 percent. These soils have moderate to rapid permeability and are in hydrologic group D and C with moderate to rapid runoff. Both soils are in the moderate erosion class and are moderate to severe erosion hazard class when disturbed. Estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. These soils can be revegetated because the fractured and weathered bedrock will retain moisture.

Unit 8 - Tortugas-Purner-Jack Soil Association.

The unit is comprised of shallow to moderately deep medium and fine textured soils on gently sloping to steep limestone and sandstone hills. The association consists of Tortugas soils, 40 percent' Purner soils, 25 percent, and Jack soils, 15 percent. The remaining 20 percent consists of rock outcrops and other related soils. Tortugas soils are shallow, six to 20 inches, very gravelly or cobbly loam over limestone bedrock. The slopes range from five to over 45 percent. Purner soils are shallow, seven to 18 inches, gravelly loam with a lime cemented layer over limestone or calcareous sandstone. Slopes range from five to 30 percent. These soils have moderate to slow permeability and are in hydrologic group D with rapid runoff. These soils are in the moderate erosion class on the lower slopes and in the severe class on the higher slopes, and moderate to high erosion hazard class when disturbed. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. Jack soils would be much easier to revegetate than the Tortugas and the Purner due to their depth and water-holding capacity.

Unit 9 - Moenkopi-Shalet Soil Association.

This unit consists of very shallow to shallow soils on sandstone and shale uplands. Slopes range from two to 15 percent but with short steep slopes on the sides of mesas and escarpments. The unit is made up of 45 percent Moenkopi, 30 percent Shalet, and 25 percent rock outcrops and deep soils in drainage ways. Moenkopi soils are shallow sandy loams over sandstone with moderately rapid permeability, very low water-holding capacity, and are in hydrologic group D (rapid runoff). Shalet soils are shallow loams over shale with slow permeability very low water-holding capcity, and are in hydrologic group D (rapid runoff). This unit would be difficult to revegetate due to low water-holding capacity.

Unit 10 - Pastura-Abra-Lynx Soil Association.

The unit is small and consists of shallow to deep, medium to fine textured alluvial soils. Pastura and Abra soils make up 35 percent each of the unit; the Lynx soils 20 percent, and 10 percent is scattered small areas of other related soils. Pastura soils are shallow gravelly loams with an extremely hard caliche pan at seven to 12 inches, and slopes one to 15 percent. The soils are moderately permeable and are in hydrologic group D with rapid runoff. Abra soils are loams to gravelly loams with strong lime zones containing many soft to hard lime segregations at eight to 28 inches and slope zero to 15 percent. The soils are moderately permeable and are in hydrologic group C with moderately rapid runoff. Lynx soils are deep loams to clay loams over clay loam subsoil in flood plains and swales with slopes from zero to three percent. Lynx soils are subject to flooding and water erosion. These soils are moderately permeable and are in hydrologic group B with moderate runoff. This unit is in the slight erosion class except for floodplains and swales which are moderate; the unit has a moderate to severe erosion hazard. The estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. This unit would revegetate using good conservation methods.

Unit 11 - Lonti-Balon-Lynx Soil Association.

The soils are deep, moderately fine textured, developed in old and recent alluvium. The association is composed of 70 percent Lonti, 15 percent Balon, and 15 percent Lynx. Lonti soils are deep gravelly or cobbly loams with clay to gravelly clay subsoils, slopes ranging from one to 35 percent. Balon soils are deep sandy clay loams with clay laom to gravelly clay loam subsoils, slopes ranging from two to 30 percent. Lynx soils are deep loam to clay loam surface and subsoils, slopes ranging from zero to three percent. These soils have moderate permeability and are in hydrologic class B, medium runoff. Present erosion condition is moderate and the erosion hazard is moderate when disturbed. These soils can be revegetated but rainfall is low.

Unit 12 - Antho-Vint-Gilman Soil Association.

This unit consists of deep soils or floodplain and lower alluvial fans. Slopes range from zero to five percent. The unit is made up of 50 percent Antho, 30 percent Vint, 10 percent Gilman, and 10 percent intermixed areas of very sandy soils. Antho soils are deep sandy loams with moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (moderately slow runoff). Vint soils are deep loamy sands with moderate rapid permeability, low water-holding capacity, and are in hydrologic group B (moderately slow runoff). Gilman soils are deep loams with moderate permeability, high water-holding capacity, and are in hydrologic group B (moderately slow runoff). This unit would be difficult to revegetate due to low annual precipitation.

Unit 13 - Cellar-Lehmans-Rock Outcrop Soil Association.

The soils are shallow to very shallow, very gravelly or cobbly and rock outcrop on gently sloping to very steep volcanic mountains and low hills. The association is composed of 25 percent Cellar, 20 percent Lehmans, 35 percent Rock Outcrop, and 20 percent other related soils. Cellar soils are very shallow, very gravelly, very cobbly, or very stony sandy loam on granite or gneiss bedrock at eight inches. Lehmans soils are shallow, cobbly loam underlain by andesite, basalt, or tuff at 14 inches. Rock Outcrop is a sandy type consisting of exposures of bedrock. The permeability of these soils is slow and they are in hydrologic group D with rapid runoff. Present erosion condition is slight and the erosion hazard when disturbed would be severe. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. The lower desert area would be very difficult to revegetate.

Unit 14 - Winkel - Rockland Soil Association.

These soils are well drained, gently sloping to steep, shallow, gravelly fine sand loams and rockland on mesas and mountain slopes of the desert basin. It is about 50 percent Winkel soils and about 30 percent Rockland. Winkel soils are formed in material weathered from basalt and limestone, mixed with sandy eolian material. Winkel soils occur on mesas and lower mountain slopes. They are shallow and well drained. Surface layer is reddish-brown, very gravelly fine sandy loam. An indurated carbonate cemented hardpan occurs at depths of 11 to 19 inches. The Rockland is mainly outcrops of basalt and limestone and areas of very shallow soil material over basalt or limestone. This association is in hydrologic group D.

Unit 15 - Barkerville-Gaddes-Rock-Outcrop Soil Association.

This unit consists of very shallow to moderately deep soils and rock outcrops on granitic hills and mountains. Slopes range from 15 to 60 percent or more. The unit is made up of 45 percent Barkerville soils, 15 percent Gaddes soils, 15 percent Rock Outcrop, and 25 percent Mirabal, Faraway, and Luzena soils. Barkerville soils are shallow sandy loams over weathered granite. Gaddes soils have a sandy loam surface over gravelly clay loam subsoils over weathered granite at 20 to 40 inches. Soils in this unit are moderate to slow in permeability, have low to very low water-holding capacity, and are in hydrologic group C (moderately rapid runoff). This unit would be difficult to revegetate.

Unit 16 - Curhollow-Pastura-Magotsu Soil Association.

These soils are well drained, nearly level to steep, shallow gravelly loams, gravelly fine sandy loams, and cobbly or very cobbly loams or mesas, alluvial fans and mountain slopes of the uplands. Soils of this association are cominantly formed in residum or alluvium from basalt or mixed sedimentary ingenous rock. Most of the soils have indurated carbonate cemented hardpan and depth of 10 to 20 inches. Curhollow soils are old alluvial fans and desert mountain slopes, shallow, well drained, gravelly fine sandy loam surface, hardpan at 10 to 20 inches. They comprise 20 percent of this unit. Pastura soils are on basalt flow mesas. They are shallow, well drained, brown gravelly loams, and have an indurated, carbonate cemented hardpan at a depth of 10 to 20 inches. Mogotsu soils occur on basalt flow mesas. They are shallow, well drained, dark brown, very cobbly loam surface layers and light clay or cobbly and gravelly clay loam subsoils over an indurated carbonate-cemented hardpan. Depth to hardpan is 15 to 20 inches. This association is in the D hydrologic group.

Unit 18 - Rough Broken Stone Land Soil Association.

These soils border the bench lands and their escarpments. Under this association are included lands which have outcroppings of bedrock, and steep slopes that are badly cut by erosion, thus lessening agricultural value. A solid lime-cemented hardpan within a foot of the surface is typical of the flat areas. The materials vary greatly in origin, color, and texture, ranging from stone and gravel to silt and clay. Many of them are old deposits firmly cemented with lime. Along the lower valley sedimentary rock materials predominate, but in the upper valley much basalt and igneous materials are present.

Unit 19 - Las Vegas Gravelly Fine Sandy Loam Soil Association.

The Las Vegas gravelly fine sandy loam association occurs principally as high benchlands. The surface is fairly level or gently rolling, surface drainage is good, and there are no accumulations of alkali. It has a surface concentration of "desert pavement" of angular or slightly rounded dark colored gravel stones. Between the stones on the surface is a loose covering of fine sand or fine sandy loam material. This surface material is underlain by a thin layer of compact, heavy, fine sandy loam materal containing considerable gravel and caliche. This is underlain by a massive lime-cemented gravel hardpan which usually is very thick. The hardpan underlying these soils has only slight limitations as foundation-bearing material for most construction but hampers underground facilities. This hardpan is too thick and hard to be shattered by ordinary ripping equipment.

Unit 20 - Corrizo-Tonopah-Pittman Soil Association.

These soils are very deep to shallow gravelly and sandy soils on nearly level to strongly sloping terraces. They are shallow soils underlain by a hardpan or cemented gravel. Carrizo soils make up approximately 78 percent of the association; they are gravelly, coarse textured, excessively drained, slightly micaceous, and mildly calcareous. Pittman soils are cobbly, stony, coarse textured and calcareous. These soils are gravelly or cobbly, and too droughty to be used for agriculture. Pittman soils are a fair to good source of sand and gravel for concrete aggregate. They have slight to moderate limitations as foundation-bearing material. There is no sulfate hazard to c [illegible] Toponah soils are very gravelly, coarse textured, calcareous and excessiv [illegible] ned. They comprise 12 percent of this unit.

Unit 21 - Rudd-Cabezon Association

This unit is made up of approximately 50 percent Rudd soils, 20 percent Cabezon soils and the remaining 30 percent is 15 percent cindery soils, similar to the Bandera series, 10 percent Rock outcrop and very shallow soils and five percent other soils. Rudd soils are gravelly to very gravelly loams that are strongly calcareous over fractured bedrock. They are found on basaltic plateaus or plains with slopes of zero to five percent. Cabezon soils are shallow, cobbly or stony loam or clay loam over fractured basalt bedrock. These soils are found between ledges of rock outcrop and on hills and mesa sides with slopes of eight to 30 percent. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils would be difficult to revegetate due to low water-holding capacity and shallow depths.

Mapping unit descriptions for California by soil groups

AC - Anthony-Cajon Arizo Association: Alluvial

Surface and subsoil textures vary from sandy loam to gravelly sand. This association occurs on nearly level to moderate sloping alluvial fans. These soils are susceptible to compaction and the erosion and siltation potential is high. The even distribution of coarse fragements and soil particles make it susceptible to compaction and decreases its percolation rate. This association is a high ORV impact area.

AM - Adelanto-Mohave Garlock Association: Red Desert

Surface textures vary from sandy to sandy loam and subsoil textures vary from sandy loam to sandy clay. This area is rated low in ORV impact and erosion and siltation potential because of the high concentration of similar size soil particles in its surface that are undisturbed because of ORV use. These soils occur on nearly level to gently sloping alluvial fans and plains.

AX - Aqua Dulce-Rough Broken Land Association: NonCalcic Brown

The surface texture is loam and the subsoil texture very gravelly clay loam. This association occurs on high terraces. The rough broken land is steep or very steep with numerous intermittent drainage channels. It has a cover of vegetation, as opposed to Badland which has sparse vegetation or complete lack of cover. This association is rated high in its ORV impact because of its highly erosive nature.

BL - Badland - San Timoteo Association: Rendzina

These areas are steep or very steep with moderately fine to fine surface textures. Geological erosion is active and the area has numerous intermittent drainage channels. Vegetation is usually very sparse. The Badlands are located on Pliocene nonmarine sedimentary rocks. This area is rated high in its ORV impact because of its highly erosive nature.

BO - Barstow-Oban-Hacienda Association: Solonetz

Surface textures vary from loamy sand to sandy loam and subsoil textures vary from sandy loam to clay loam. Soils in this assocation are rated high in ORV impact and high in erosion and siltation potential because of their susceptibility to compaction. These soils have a high concentration of sodium making them undesirable for plant growth. This association occurs on terraces, alluvial fans, and valley troughs.

BR - Bull Trail-Rough Broken Land Association: NonCalcic Brown

The surface texture is sandy loam and the subsoil texture clay loam for the Bull Trail series. It occurs on high terraces and alluvial fans. The rough broken land area has a wide range of surface textures with steep or very steep slopes and numerous intermittent drainage channels. This association is rated high in its ORV impact because of its high compactability and high erosion potential.

CH - Calvista-Hivista-Cinco Association: Lithosol-Red Desert-Regosol

Surface texture range from sandy loam to loamy sand and subsoil textures vary from loamy sand to clay loam. These soils occur on nearly level to strongly sloping uplands. These soils are moderately compacted and their erosion potential moderate. This association is considered medium in ORV impact.

CL - Crouch-La Posta-Glenbrook Association: Brunizem-Regosol-Lithosol

Surface and subsoil textures vary from sandy loam to loamy sand. The major portion of this association occurs on gently sloping to steep uplands in areas of deeply weathered granitic rocks. This association is rated as a high ORV impact area because of its high compactability causing reduced perolation rates. Erosion potential is moderate because of reduced percolation rate and moderately steep slopes.

CM - Coachella-Mecca-Indio Association: Alluvial

Surface textures range from sand to sandy loam and subsoil textures from sand to silt loam. These soils occur on nearly level to gently sloping flood plains and basins. This association is rated low in ORV impact because its sand surface makes it resistant to any compaction. Erosion and siltation potential for this association is low because of its high infiltration rates and nearly level position.

CO - Calpine Oak Glen-Mottsville Association: Brunizem-Alluvial

Surface textures range from sandy loam to loamy sand and subsoil textures range from clay loam to loamy sand. These soils occur on nearly level to moderately steep fans and low terraces. They formed in alluvium derived mostly from granitic and related rock sources. This association is considered medium in ORV impact and erosion and siltation potential.

CL - Crouch-La Posta-Glenbrook Association: Brunizem-Regosol-Lithosol

Surface and subsoil textures vary from sandy loam to loamy sand. The major portion of this association occurs on gently sloping to steep uplands in areas of deeply weathered granitic rocks. This association is rated as a high ORV impact area because of its high compactability causing reduced percolation rates. Erosion potential is moderate because or reduced percolation rate and moderately steep slopes.

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Surface textures range from sand to sandy loam and subsoil textures from sand to silt loam. These soils occur on nearly level to gently sloping flood plains and basins. This association is rated low in ORV impact because its sand surface makes it resistant to any compaction. Erosion and siltation potential for this association is low because of its high infiltration rates and nearly level position.

CO - Calpine Oak Glen-Mottsville Association: Brunizem-Alluvial

Surface textures range from sandy loam to loamy sand and subsoil textures range from clay loam to loamy sand. These soils occur on nearly level to moderately steep fans and low terraces. They formed in alluvium derived mostly from grantitic and related rock sources. This association is considered medium in ORV impact and erosion and siltation potential.

CR - Cieneba-Rockland-Fallbrook Association: Lithosol-NonCalcic Brown

This association has well drained and somewhat excessively drained, undulating to steep, very shallow to moderately deep soils that have a surface layer of sandy loam and fine sandy loam on granitic rocks.

CT - Cajalco- Las Posas Association: Lithosols

These are well drained, undulating to steep, moderately deep to shallow soils that have a surface layer of fine sandy loam and loam.

DR - Duneland Association: ---

These are areas of high hills or ridges of sand sized particles drifted and piled by the wind. The majority of these dunes are on or around margins of playas and were formed from shores of old Pleistocene lakes. The high concentration of similar size sand particles makes it highly resistant to compaction and is considered low in ORV impact. The erosion and siltation potential is also low.

DT - Daggett-Toponah-Bitter Spring Association: Calcisol

Surface textures vary from gravelly sandy loam to sand and sub-soil textures vary from very gravelly sandy loam to gravelly sand. These soils occur on convex and smooth, nearly level to strongly sloping alluvial fans and terraces. These soils formed in very gravelly sandy alluvium from a variety of rocks, predominantely grantitic with some basaltic and rhyolitic materials. This association is high in ORV impact because of its susceptibility to compaction and its high erosion and siltation potential.

FE - Friant-Escondido Association: Lithosol-NonCalcic Brown

These soils are well drained and somewhat excessively drained, undulating to steep, shallow to deep soils tht have a surface layer of rocky fine sandy loam and gravelly loam on metamorphosed sandstone and mica-schist.

GR - Granite Rockland: ---

These are areas with granite rock outcrops. The soil is very shallow to none in most places. This area is considered low in ORV impact because of its high percentage of rocks and lack of soil. The erosion and siltation potential is low because of lack of soil.

HT - Hanford-Tumunga-Greenfield Association: Alluvial - Alluvial-NonCalcic Brown

These soils are very deep, well drained to excessively drained, nearly level to moderately steep soils that have a surface layer of sand to sandy loam. Such soils are found on alluvial fans and flood plains.

IH - Imperial-Holtville Association: Regosol

The surface texture of this association is clay and subsoil textures vary from clay to clay loam. Soils in this association occur on nearly level flood plains or lacustrine basins. These fine textured soils are considered high in ORV impact because of their susceptibility to compaction resulting in reduced percolation rates.

IT - Indo-Termal Association: Regosol

Surface textures range from sandy loam to clay loam and subsoil textures range from silt loam to clay loam. These soils are on nearly level flood plains and basins at elevations of 200 feet below sea level to 300 feet above sea level. The parent material consists of recent alluvium derived from a variety of rock sources and deposited by the Colorado River and other streams. This association is considered high in ORV impact because of its high compaction potential.

LR - Lava Rockland Association: ---

These are extensive areas with volcanic material. The soil is very shallow to none. This is considered a low ORV impact area and low potential for erosion and siltation because a great majority of the area is devoid of any soil and is made up of barren volcanic material.

MA - Monserate-Arlington-Exeter Association: NonCalic Brown

These soils are well drained, nearly level to moderately steep soils with a surface layer of sandy loam to loam and are shallow to deep in a hardpan.

MJ - Mariposa-Josephine-Sites Association: Laterite

Surface textures range from gravelly silt loam to loam and subsoils range from gravelly silt loam to clay. Depths vary from shallow to very deep. This association occurs on gently sloping to steep mountainous uplands. This association is considered a high ORV impact area and a high erosion area because of its high compactability and moderately steep to steep slopes.

NI - Niland-Imperial Association: Regosol

Surface textures of this association vary from gravelly sand to clay and subsoil texture is clay. These soils occur on flood plain edges or nearly level flood plains. The major portion of this association has a surface texture of gravelly sand or sand approximately 14 to 36 inches thick. This association is considered low in ORV impact and low in erosion potential because of its high resistance to compaction and high infiltration rates.

OJ - Ophir-James Canyon-Bishop Association: Humic Gley

Surface textures range from gravelly sandy loam to loam and subsoil textures vary from gravelly loamy sand to clay loam. These are poorly drained soils in stream bottoms or upland meadows. This association is high in ORV impact because its high organic matter content and high water table make it very susceptible to compaction.

RL - Rosamond-Land-Playas Association: Alluvial

Textures in this association are usually moderately fine or fine. These soils occur on the lower margins of fans, between sloping fans and basins, and playas. Slopes are nearly level to level and soils are formed in alluvium derived mostly from granitic and similar rocks. These soils are considered a low ORV impact area because of their low erosion and siltation potential.

RM - Rositas-Mecca-Meloland Association: Regosol

Surface textures range from fine sand to sandy loam and subsoil texture ranges from sand to clay. These soils are formed in sand blown from recent alluvium and nearly level lacustrine basins. These soils are considered a medium ORV impact area and have a medium erosion and siltation potential. Because of the gradation of soil particles within the surface horizon these soils can be moderately compacted.

SG - San Emigdio-Grangeville-Metz Association: NonCalcic Brown

These are very deep, poorly drained to somewhat excessively drained, nearly level to strongly sloping soils that have a surface layer of calcareous loamy sand to loam. Such soils are found on alluvial fans and flood plains.

SI - Supan-Iron Mountain Association: NonCalci Brown-Lithosol

Surface textures range from loam to sandy loam and subsoil textures range from loam to clay loam. These soils occur on sloping, plateau like areas or steep slopes and narrow divides at elevations of 1,500 to 5,000 feet. Underlying rock is andesitic and basaltic tuff-breccia or similar rock. This association is considered medium in ORV impact and erosion and siltation potential.

SS - San Andreas-San Benito Association: Brunizems-Chestnut

Soils within this association occur on mountainous slopes ranging from 30 to 75 percent. Surface soils are sandy loam in texture. As affected by the proposed Kaiparowits transmission system, little detrimental effect is expected although moderate erosion is already present.

TC - Toiyabe-Corbett-Granite Rockland Association: Lithosol-Regosol

Surface textures range from coarse sandy loam to loamy sand and subsoil textures range from loamy coarse sand to loamy sandy. These soils occur on sloping to very steep mountainous areas. The major portion of this association has soil depth that are shallow to bedrock. This association is rated high in ORV impact because of its susceptibility to compaction and its high erosion potential.

TD - Traver-Domino-Willows Association: Solonetz - Grumosol

Moderately drained to poorly drained, these saline-alkali soils occur on nearly level to gently sloping surfaces. The surface layer is a loamy fine sand to silty clay; they are moderately deep to very deep with a calcareous hardpan.

TE - Tivy-Exchequer Association: NonCalcic Brown-Lithosol

Soils of this association occur in rocky steep areas with slopes ranging from 30 to 75 percent. In general these soils exhibit moderate amounts of erosion. Such soils occur in coastal mountain areas of Orange County transected by the proposed Kaiparowits transmission line. Surface texture is generally coarse sandy loam.

TP - Thermal-Playas Association: Regosol

Textures in this association are usually moderately fine or fine. These soils occur on lacustrine basins and playas. The major portion of this association is located in areas of playas. Slopes are nearly level to level and are formed in fine and moderately fine "silty" alluvium derived from a variety of rock sources. This association is considered low in ORV impact because of its low erosion and siltation potential and low compactability.

TS - Tujunga-Soboba-Riverwash Assocation: Alluvial

Surface textures range from sand to loamy sand and subsoil textures range from sand to very gravelly sand. These soils occur on fans, flood plains and drainage ways and are formed in alluvium derived mostly from granitic sources. This association is considered low in ORV impact because of its resistance to compaction and low erosion potential.

TW - Tortugas-Winona Association: Lithosol

Surface and subsoil texture for this association is cobbly loam.

These soils occur on moderately steep to very steep mountainous areas. These soils are very shallow to bedrock. This association is considered high in ORV impact because of its high erosion and siltation potential.

VB - Vinton-Brazitos-Dune Land Association: Alluvial

Surface textures range from sand to sandy loam with the majority of the area having loamy sand textures. Subsoil textures range from sand to loamy sand. These soils occur on nearly level or very gently sloping flood plains or low terraces. This association is considered medium in ORV impact and erosion potential.

XA - Aco-Acolita-Rositas Association: Alluvial-Red Desert-Regosol

Surface and subsoil textures vary from sandy loam to sand. These soils occur on nearly level to gently sloping terraces slightly above the flood plain or low dunes or dune ridges. These soils were developed in wind-modified coarse and moderately coarse textured sediments derived from mixed sedimentary and crystalline rocks. This association is considered medium in ORV impact and erosion potential.

XC - Sheephead-Crafton Association: Lithosol-Regosol

Textures of the surface horizon range from sandy loam to loamy fine and subsoil texture is gravelly sandy loam. These soils occur on moderately sloping to very steep uplands at elevations of 2,500 to 6,000 feet. This association is considered high in ORV impact because of its susceptibility to erosion and siltation.

XO - Chuckwalla-Orita-Rough Broken Land Association: Red Desert

Surface textures range from gravelly silt loam to loamy sand and subsoil textures range from very gravelly clay loam to fine sandy loam. Some of the area has high concentrations of sodium making it undesirable for plant growth. These soils occur on old fans and terraces with nearly level to level slopes. These soils are developed in somewhat stratified alluvium derived from a wide variety of rocks. This association is considered medium in ORV impact and erosion and siltation potential.

XR - Carrizo-Riverwash Association: Alluvial

Textures of surface and subsoil range from gravelly sand to sand. These soils occur on nearly level to moderately sloping flood plains and recent alluvial fans and also drainage ways. This association is considered low in ORV impact and erosion and siltation potential because of its resistance to compaction and high infiltration rate.

Soil Interpretations

Page 1 of 3

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
1	Low	High	Good	Poor	Good	Slight	Slight	Severe	Slight	Severe	Slight	Severe
1A	High	High - uncoated steel; low for concrete	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
1B	Moderate	Low	Good on slopes less than 15%; Poor on slopes greater than 15%	Unsuitable	Poor	Moderate on slopes less than 15%; severe otherwise	Severe	Severe	Severe	Severe	Severe	Severe
1D	High	High to moderate for uncoated steel; low for concrete	Poor to fair	Unsuitable	Poor	Severe	Moderate to Severe	Severe	Moderate to Severe	Moderate to Severe	Moderate to Severe	Moderate to Severe
2	Low	High	Poor	Poor	Poor	Severe	Severe	Severe	Moderate	Severe	Severe	Severe
2A	Low to Moderate	Moderate to high for uncoated steel; Low for concrete	Poor	Unsuitable	Poor	Severe Bedrock 10 to 20 inches	Severe	Severe	Severe	Severe	Severe	Severe
3	Low	High	Good	Poor	Good	Slight	Slight	Severe	Slight	Severe	Slight	Slight
3A	Shoulow High; Pastura Low; Paley High	High for steel; Low for concrete	Fair to Poor	Unsuitable All	Poor All	Severe All	Shoulow & Pastura Severe; Paley Moderate	Severe All	Shoulow Severe; Pastura & Paley Moderate	Shoulow Moderate; Pastura Severe; Paley Slight	Shoulow & Paley Moderate; Pastura Severe	Severe All

*Engineering limitations (Slight, Moderate, Severe)

FIGURE 1

Soil :pretations

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
4	High	High	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Slight - Springerville; Severe - Cabezon	Moderate - Springerville; Severe - Cabezon	Severe
4A	Low	High for Uncoated steel; May be high for concrete in local areas	Poor shallow to Bedrock	Unsuitable	Poor to fair	Severe Bedrock 5 to 20 inches	Severe	Severe	Severe	Severe	Severe	Severe
4B	Low	Moderate	Fair	Unsuitable	Good	Slight	Slight	Slight	Slight	Severe	Slight-Subject to piping	Slight
4C	Low	Low	Good	Fair for sand; unsuitable for gravel	Poor sandy low water holding capacity	Slight	Moderate	Slight	Moderate	Moderate	Slight	Slight
4D		High uncoated steel; Moderate concrete	Good to Fair	Unsuitable	Poor	Slight to Severe	Slight to Severe	Slight to Severe	Slight to Severe	Moderate to Severe	Severe	Slight to Severe
5	Low	High	Fair to Good	Unsuitable	Good	Slight	Slight	Slight	Slight	Severe	Moderate	Slight
5A	TOO VARIABLE IN CHARACTERISTICS FOR VALID ESTIMATES ----------											
6	Low	Low	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
7	Low	Low	Poor	Unsuitable	Poor	Severe	Severe	Severe	-do-	-do-	-do-	-do-

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
8	Low Tortugas & Purner; Moderate Jacks	Low - Tortugas; Moderate Purner; High - Jacks	Poor All	Unsuitable All	Poor - All	Severe - All	Severe - All	Severe - All	Severe - Tortugas & Purner Moderate	Same	Same	Severe - All
9	Low	High	Poor	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
10	Low for Pastura & Abra; High-Lynx	High to Moderate	Poor to Fair	Poor	Poor - Pastura Fair-Abra Good-Lynx	Moderate to Severe	Severe - Pastura Slight-Abra Moderate-Lynx	Severe - Pastura Slight-Abra Moderate Lynx	Moderate All	Severe - Pastura Moderate Abra Slight-Lynx	Severe - Pastura Slight-Abra Moderate-Lynx	Severe - Pastura Slight-Abra Moderate Lynx
11	Moderate	Moderate	Fair	Poor	Poor	Severe	Moderate	Severe - Lonti; Moderate - Balon & Lynx	Severe - Lonti; Slight - Balon Moderate - Lynx	Slight to Moderate	Moderate	Moderate
12	Low	High	Fair	Poor	Poor	Slight	Slight	Severe	Slight	Severe	Slight	Slight
13	Low Cellar High - Lehmans	Moderate Uncoated steel; low concrete	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
14	Low	High	Fair	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
15	Moderate	Barkerville High; Gaddes Low	Fair to Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Moderate	Severe
16	High	Moderate	Poor	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
18	TOO VARIABLE IN CHARACTERISTICS FOR VALID ESTIMATES ----------											
19	Moderate	Slight	Severe	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Slight
20	Slight	Slight	Severe	Poor	Poor	Fair	Slight	Severe	Slight	Slight	Moderate	Moderate
21	Low	Low	Poor	Unsuitable	Poor	Severe	Moderate	Severe	Severe	Severe	Moderate	Severe

APPENDIX II-7

Surface Water

APPENDIX II-7

Water Resources

Kaiparowits Plateau impact area

Surface water

Data presented in Figure 1 and Illustration 1 were collected by researchers from Northern Arizona University. The data supports conclusions cited in the Water Resources section of Chapter II.

FIGURE 1

Averaged Physico-chemical Parameters for Warm Creek and Wahweap Bays. (March-May 1972)
(Sample numbers refer to the sites shown in the following Illustration 1)

Sample	NO_3	NO_2	$O-PO_4$	Fe	Si mg/l	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay										
WC 1 surface	2.13	.033	.050	.13	9.87	10.49	.813	7.75	11.7	.75
WC 1 bottom	2.22	.003	.050	.135	10.62	10.65	.853	7.70	11.5	--
WC 2 surface	1.94	.006	.050	.07	9.37	10.55	.802	7.97	11.25	3.21
WC 2 16.4 feet	1.81	.010	.035	.045	10.125	10.74	.793	7.90	9.77	--
WC 2 32.8 feet	2.00	.006	.025	.07	9.75	10.29	.784	7.80	9.8	--
WC 2 49.2 feet	2,16	.004	.010	.05	9.50	9.52	.795	7.60	7.5	--
WC 2 bottom	2.24	.026	.055	.16	10.125	9.15	.795	7.80	9.0	--
WC 4 surface	1.87	.007	.020	.07	10.05	10.65	.793	7.93	10.7	4.64
WC 4 16.4 feet	2.20	.005	.030	.05	10.65	10.74	.797	7.92	9.7	--
WC 4 32.8 feet	2.17	.003	.045	.08	10.25	10.66	.791	7.87	8.9	--
WC 4 49.2 feet	2.15	.004	.055	.06	10.25	9.73	.824	7.86	8.5	--
WC 4 bottom	2.42	.033	.085	.08	11.50	8.87	.853	7.70	7.9	--

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO_3	NO_2	$O-PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay														
WC 1 surface	.726	.028	.040	.080	5.73	200	41.3	96.0	5.55	8.37	.772	8.40	24.9	0.51
WC 1 bottom	2.43	.028	.226	.330	7.38	310	60.5	122.6	0	7.59	.882	8.10	23.5	--
WC 2 surface	1.32	.042	.040	.196	7.85	240	46.3	94.8	5.65	9.05	.883	8.53	25.1	1.91
WC 2 16.4 feet	1.06	.026	.025	.015	7.53	275	47.5	96.2	4.85	9.12	.913	8.36	23.1	--
WC 2 32.8 feet	1.79	.046	.040	.025	7.52	250	46	96.2	4.85	7.99	.896	8.20	20.06	--
WC 2 49.2 feet	2.67	.287	.100	.146	7.55	260	45	122.9	0	5.45	.913	7.85	18.6	--
WC 2 bottom	2.90	.160	.090	.145	8.32	250	47.5	127.1	0	3.46	.905	7.56	18.25	--
WC 4 surface	1.102	.017	.036	.020	7.63	250	50	94.8	5.54	9.35	.855	8.53	25.6	3.48
WC 4 16.4 feet	2.19	.025	.030	.046	8.20	245	46	123.1	0	9.59	.873	8.46	24.7	--
WC 4 32.8 feet	2.08	.040	.020	.040	7.60	250	41.25	124	0	8.24	.887	8.33	24.3	--
WC 4 49.2 feet	1.84	.079	.038	.050	8.23	240	46.5	110.2	0	7.4	.904	8.10	18.5	--
WC 4 bottom	3.25	.021	.040	.186	10.83	268	54.5	132.4	0	5.15	.930	7.73	14	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	(NO$_3$)-	(NO$_2$)	(O-PO$_4$).	(Fe)	Si mg/l	SO$_4$	Cl	HCO$_3$	CO$_3$	O$_2$	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay														
WC 1 surface	1.27	.019	.093	.020	9.18	300	45	108.5	.22	8.83	.944	8.20	20.5	1.06
WC 1 bottom	1.05	.141	.020	.016	9.90	320	45	95.9	12.60	8.83	.944	8.23	20.56	--
WC 2 · surface	1.09	.016	.020	.013	10.18	280	45	103.4	4.20	8.94	.905	8.23	15.3	2.59
WC 2	.999	.017	.025	.040	9.41	298	44.5	102.4	5.26	8.91	.943	8.21	20.6	--
16.4 feet WC 2	1.195	.020	.033	.016	9.83	280	47.5	102.4	5.26	8.72	.950	8.21	20.63	--
32.8 feet WC 2	1.476	.053	.031	.046	9.21	300	47.5	128.1	0	6.20	.946	7.98	19.8	--
49.2 feet WC 2 bottom	1.64	.028	.065	.080	10.20	310	45	132.3	0	5.86	.948	7.95	19.26	--
WC 4 surface	1.04	.018	.042	.013	9.48	250	45	101.9	6.30	9.12	.905	8.23	20.56	4.31
WC 4	1.128	.017	.019	.010	9.48	240	45	96.4	12.82	8.97	.905	8.36	20.5	--
16.4 feet WC 4	1.165	.0236	.025	.036	9.48	230	47.5	104.0	8.4	8.94	.905	8.23	20.5	--
32.8 feet WC 4	1.52	1.510	.011	.043	9.60	233	45	117.6	0	7.24	.862	8.08	20.16	--
49.2 feet WC 4 bottom	2.64	.016	.028	.018	11.13	250	47.5	132.8	0	4.2	.948	7.78	15.1	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO$_3$	NO$_2$	O-PO$_4$	Fe	Si mg/l	SO$_4$	Cl	HCO$_3$	CO$_3$	O$_2$	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay														
WC 1 surface	2.06	.012	.021	.033	7.65	230	45	121.5	0	11.39	--	7.90	7.56	2.17
WC 1 bottom	1.76	.695	.025	.050	7.71	260	45	125.4	0	11.41	--	7.90	7.56	--
WC 2 surface	1.77	.009	.068	.030	8.72	230	45	122.7	0	10.74	--	7.93	8.76	3.16
WC 2	2.01	.008	.025	.010	7.78	225	45	123.8	0	10.78	--	7.86	8.13	--
16.4 feet WC 2	1.91	.009	.041	.025	7.60	210	45	120.4	0	10.74	--	7.91	7.8	--
32.8 feet WC 2	1.65	.004	.010	.010	8.43	230	45	124.3	0	10.68	--	7.90	8.0	--
49.2 feet WC 2 bottom	1.94	.005	.505	.030	7.40	220	40	123.2	0	10.74	--	7.90	7.93	--
WC 4 surface	2.02	.011	.023	.026	8.15	250	45	121.5	0	10.37	--	7.80	8.6	4.09
WC 4	1.86	.010	.037	.016	9.30	230	45	128.2	0	10.34	--	7.85	8.43	--
16.4 feet WC 4	2.01	.014	.020	.046	8.06	220	45	121.5	0	10.29	--	7.86	8.5	--
32.8 feet WC 4	2.04	.010	.028	.016	9.43	250	45	124.9	0	10.30	--	7.83	8.5	--
49.2 feet WC 4 bottom	2.54	.007	.054	.060	8.53	240	45	138.8	0	10.14	--	7.86	7.6	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample Wahweap Bay	NO_3	NO_2	O-PO_4	Fe	Si mg/l	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wa 11 surface	2.07	.007	0.100	.180	9.70	10.63	.826	7.98	12.3	.845
Wa 11 bottom	2.38	.006	.130	.160	9.25	10.96	.879	8.01	11.95	--
Wa 12 surface	1.67	.007	.040	.080	9.20	10.96	.791	8.00	9.8	3.16
Wa 12 16.4 feet	2.105	.007	.015	.060	9.90	11.13	.793	8.05	9.25	--
Wa 12 32.8 feet	1.95	.009	.025	.065	10.30	11.08	.793	7.93	8.65	--
Wa 12 49.2 feet	1.63	.009	.030	.040	9.75	9.93	.793	7.80	7.90	--
Wa 12 bottom	1.90	.006	.045	.045	8.63	10.40	.829	9.95	8.5	--
Wa 14 surface	1.97	.006	.050	.030	9.13	10.98	.809	8.08	11.05	4.6
Wa 14 16.4 feet	2.08	.008	.030	.065	8.75	11.28	.776	7.83	10.5	--
Wa 14 32.8 feet	2.00	.006	.090	.030	9.125	11.08	.774	7.98	9.95	--
Wa 14 49.2 feet	1.95	.007	.005	.035	9.32	10.47	.776	7.78	8.55	--
Wa 14 bottom	2.29	.009	.055	.085	9.63	9.94	.774	7.75	8.45	

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample Wahweap Bay	NO_3	NO_2	O-PO_4	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wa 11 surface	1.16	.020	.05	36	8.18	250	45	101.3	12.4	9.31	.824	8.60	24.1	1.02
Wa 11 bottom	1.23	.060	.04	.16	8.05	267.5	42.5	124.9	0	7.58	.826	8.42	21.4	--
Wa 12 surface	1.00	.030	.04	.05	7.05	260	47.5	101.2	14.35	9.36	.859	8.60	24.3	2.58
Wa 12 16.4 feet	1.21	.040	.02	.06	7.94	263	44.3	107.1	7.72	9.29	.844	8.50	23.8	--
Wa 12 32.8 feet	1.10	.009	.02	.06	9.18	277.5	38.0	122.1	0	8.09	.859	8.28	21.4	--
Wa 12 49.2 feet	1.46	.050	.05	.07	8.63	312.5	53.0	124.5	0	6.10	.833	7.95	18.5	--
Wa 12 bottom	2.69	.040	0.10	.19	9.13	325	64.3	132.2	0	5.26	.879	7.82	16.5	--
Wa 14 surface	.91	.020	.02	.04	8.20	237	47.7	100.0	8.76	9.22	.846	8.48	25.0	3.52
Wa 14 16.4 feet	.90	.001	.06	.05	7.43	240	45.0	101.5	8.41	9.47	.865	8.58	24.4	--
Wa 14 32.8 feet	.79	.022	.08	.03	7.81	242.5	43.8	123.5	0	9.37	.863	8.45	21.8	--
Wa 14 49.2 feet	.68	.013	.04	.07	7.31	198.0	42.5	110.6	10.04	8.87	.804	8.30	18.77	--
Wa 14 bottom	2.77	.030	.04	.32	10.35	240	40.0	126.4	0	5.46	.884	7.80	14.4	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

7 of 8

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wahweap Bay														
Wa 11 surface	.93	.025	.060	.08	8.40	220	47.5	103.4	4.2	9.06	.956	8.23	19.1	1.08
Wa 11 bottom	.86	.021	.080	.047	8.30	260	47.5	103.5	0	9.06	.986	8.25	19.1	--
Wa 12 surface	.96	.017	.020	.04	8.20	210	47.5	98.1	8.04	8.96	.927	8.30	19.7	3.05
Wa 12 16.4 feet	.81	.029	.020	.04	9.02	240	47.5	99.24	7.36	8.94	.900	8.30	19.7	--
Wa 12 32.8 feet	.83	.015	.020	.03	8.42	240	47.5	107.1	9.46	8.95	.939	8.22	19.7	--
Wa 12 49.2 feet	.83	.021	.018	.04	8.52	220	47.5	104.4	3.16	8.78	.931	8.20	19.6	--
Wa 12 bottom	1.32	.013	.020	.04	8.67	220	47.5	130.2	0	6.14	.948	7.93	18.5	--
Wa 14 surface	.93	.017	.023	.033	7.90	200	45.0	98.7	8.40	9.04	.913	8.30	19.9	4.45
Wa 14 16.4 feet	.97	.014	.045	.04	8.65	200	47.5	99.24	7.36	9.03	.939	8.28	19.9	--
Wa 14 32.8 feet	.94	.016	.020	.04	8.05	210	47.5	98.74	7.36	8.99	.913	8.32	19.9	--
Wa 14 49.2 feet	.97	.118	.290	.05	8.30	210	47.5	91.8	15.8	8.59	.913	8.28	19.8	--
Wa 14 bottom	2.01	.011	.300	.05	9.20	225	45.0	130.7	0	3.91	.939	7.80	16.1	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

8 of 8

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wahweap Bay														
Wa 11 surface	1.92	.015	.020	.02	7.50	230	45	125.4	0	11.39	--	7.88	7.5	1.94
Wa 11 bottom	1.58	.013	.030	.05	7.46	260	45	121.5	0	11.46	--	7.83	7.5	--
Wa 12 surface	1.69	.007	.020	.03	8.90	230	45	122.1	0	10.89	--	7.90	8.1	3.12
Wa 12 16.4 feet	2.01	.016	.020	.02	7.93	225	45	122.1	0	10.90	--	7.85	8.1	--
Wa 12 32.8 feet	1.92	.012	.030	.02	7.61	210	45	106.0	0	10.95	--	7.85	7.9	--
Wa 12 49.2 feet	1.73	.009	.030	.004	8.35	230	45	122.1	0	11.00	--	7.92	7.9	--
Wa 12 bottom	1.92	.013	.012	.033	7.62	220	40	122.1	0	10.83	--	7.88	7.7	--
Wa 14 surface	1.96	.013	.030	.008	8.23	250	45	126.6	0	10.74	--	7.87	8.6	4.24
Wa 14 16.4 feet	1.87	.015	.024	.03	9.38	230	45	123.8	0	10.70	--	7.83	8.3	--
Wa 14 32.8 feet	1.99	.016	.027	.03	7.93	220	45	124.3	0	10.67	--	7.90	8.4	--
Wa 14 49.2 feet	2.13	.008	.022	.03	7.85	250	45	125.4	0	10.61	--	7.86	8.2	---
Wa 14 bottom	2.14	.031	.051	.06	7.90	240	45	126.0	0	10.61	--	7.90	8.2	--

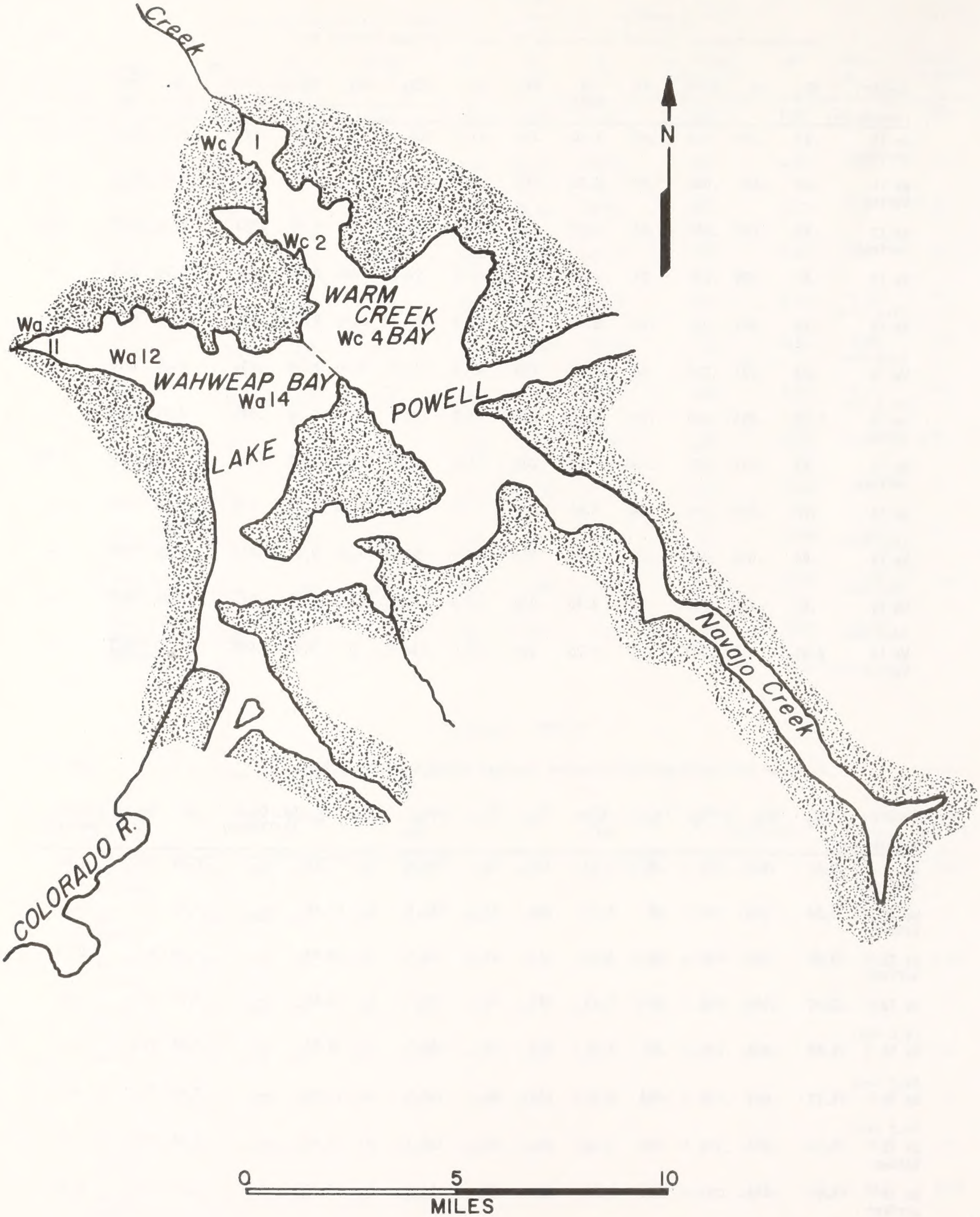


ILLUSTRATION 1

Sampling Sites for Physico-Chemical Analysis
- Lake Powell

APPENDIX II - 8

Vegetative Types, Description and Distribution Percentage for Kaiparowits Plateau Impact Area

APPENDIX II-8

Vegetation

Kaiparowits Plateau impact area

Vegetative types, description and distribution percentage for Kaiparowits Plateau impact area

Pinyon-Juniper Woodland - This vegetative type generally occupies higher elevations where precipitation is highest and cooler temperatures exist. Distribution: 28 percent.

Mixed Desert Shrubs - Dominated by blackbrush and spiny hopsage, this vegetative type occupied several benchlands in the study area. Distribution: 21 percent.

Salt Desert Shrubs - This vegetative type generally exists on moderate slopes and benchlands where soil is rocky and poorly drained. Salt accumulation is often apparent on the soil surface. Distribution: 12 percent.

Desert Grasslands - These grasslands are generally dominated by various combinations of pure stands of indian ricegrass, sand dropseed, blue grama and galleta grass. The soils are quite well drained and are generally deeper than soils exhibiting other vegetative types. Distribution: seven percent.

Sagebrush - Almost pure stands of sagebrush occur within the larger vegetative types. These sagebrush dominated communities most often occur on relatively level areas where alluvial deposition has occurred. Distribution: four percent.

Wasteland - This category is used to stratify all steep and rocky areas where vegetative ground cover exceeds two percent. These areas are sparsely vegetated with shallow soil and are normally not accessible for livestock use. Distribution: 25 percent.

Barren - This category is used to classify land area, which is normally completely devoid of vegetative cover. The most common land forms on which this situation occurs are rock outcrops and saline flats. Distribution: three percent.

ILLUSTRATION 1

Barren Area (Tropic Shale Formation in middle)

ILLUSTRATION 2

Wasteland Area

ILLUSTRATION 3

Pinyon-juniper (Sagebrush Park Upper Left)

ILLUSTRATION 4

Mixed Desert Shrub

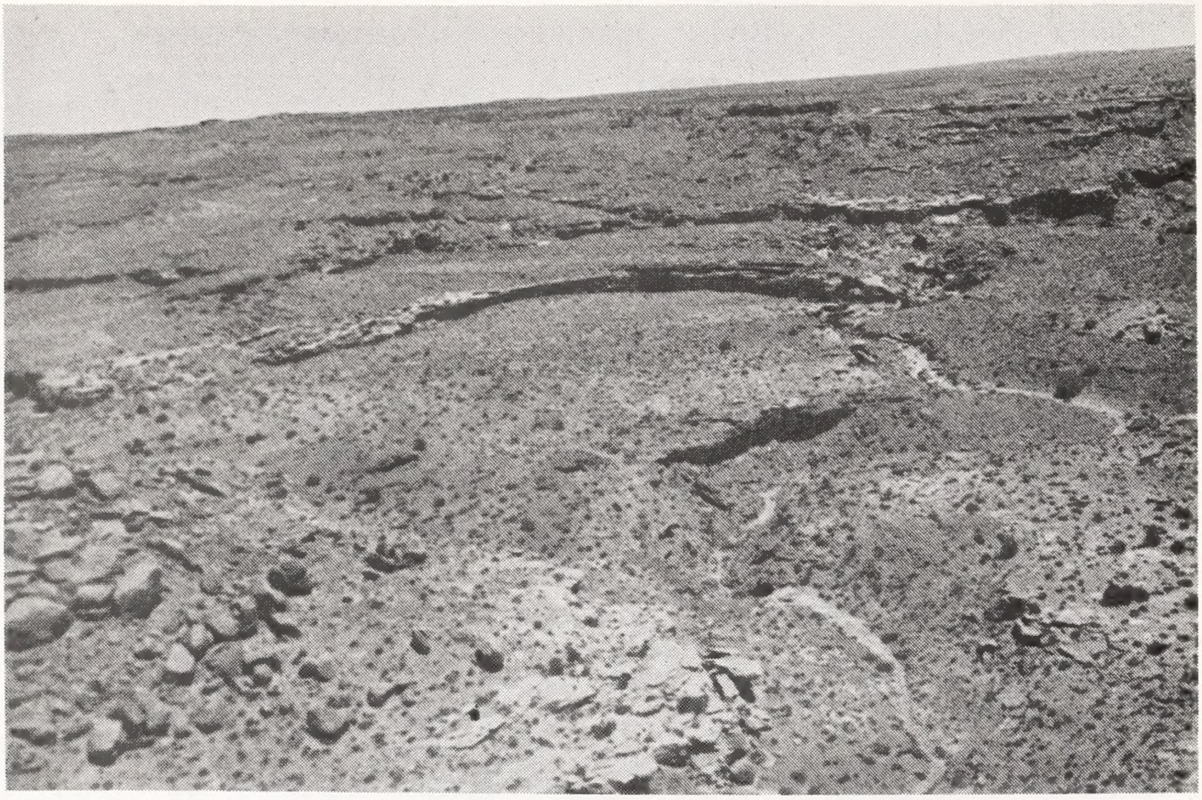


ILLUSTRATION 5

Salt Desert Shrub Type

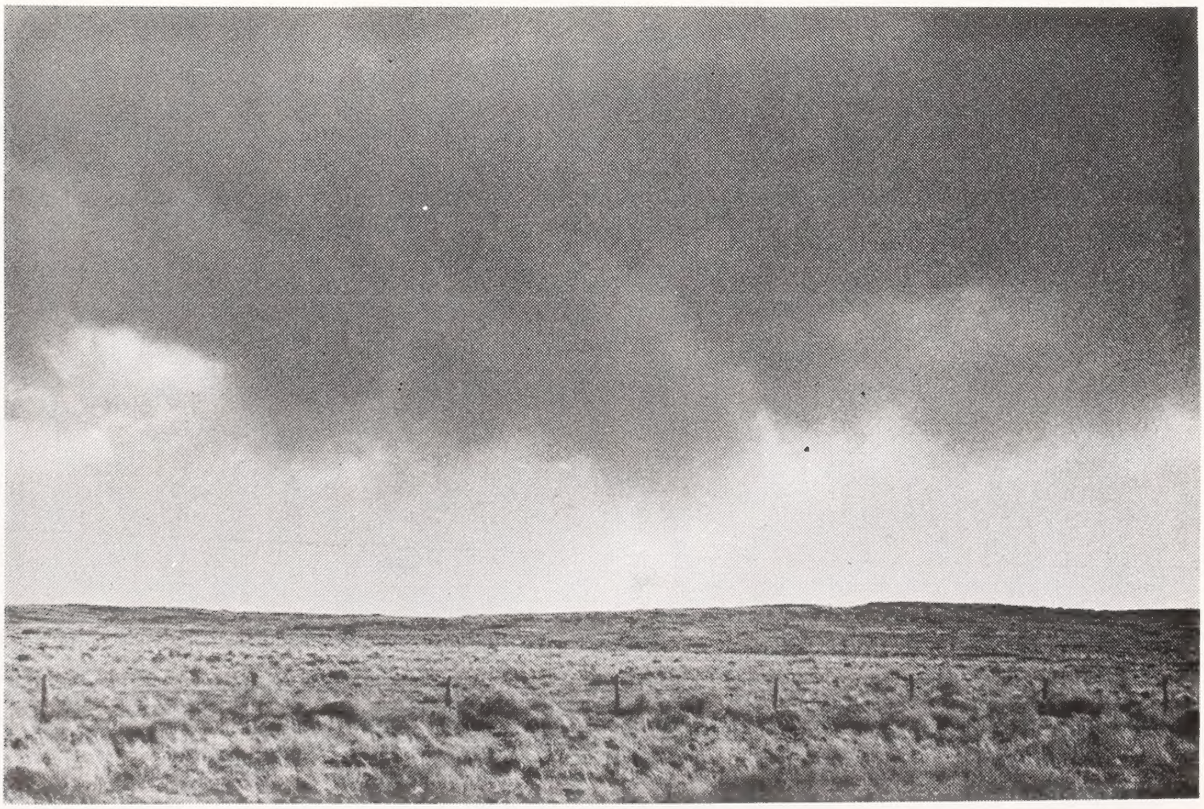
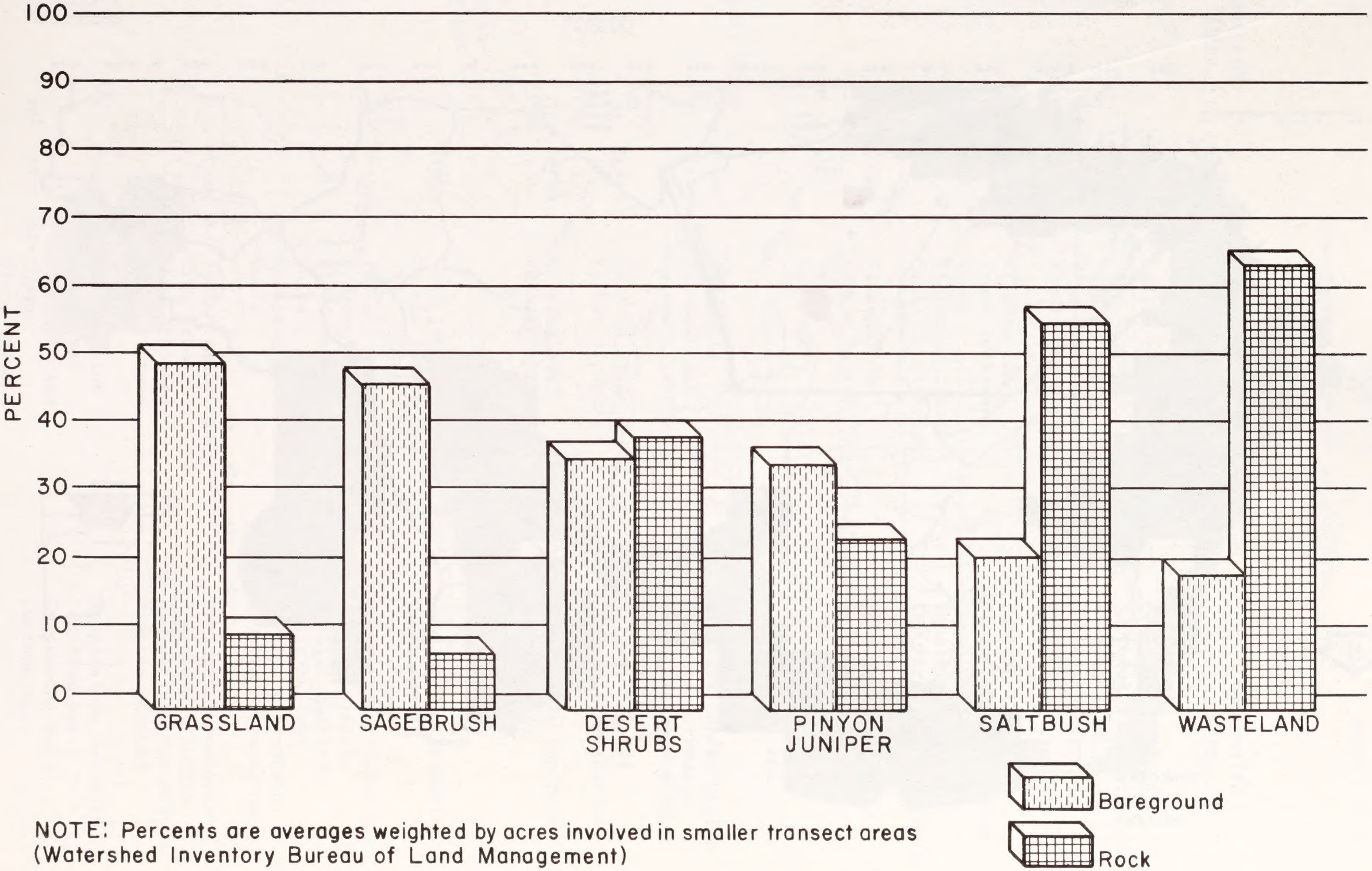


ILLUSTRATION 6

Grassland

FIGURE 1

Vegetative Types for Kaiparowits Impact Area



NOTE: Percents are averages weighted by acres involved in smaller transect areas (Watershed Inventory Bureau of Land Management)

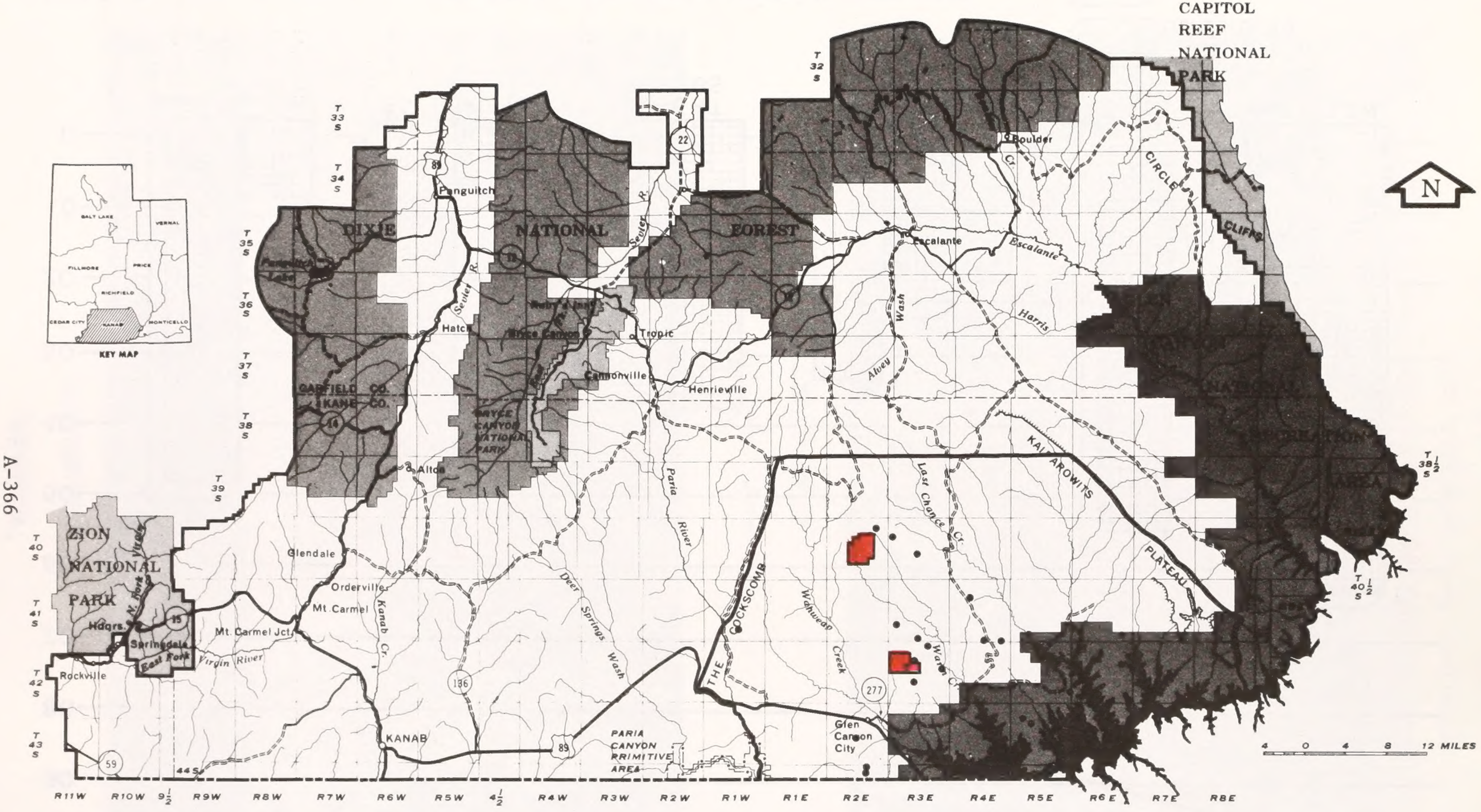


ILLUSTRATION 7

B.Y.U. Permanent Study Sites
Within the Kaiparowits Plaeau Impact Area

FIGURE 2

Common Species Ranked by Average Relative Importance

Vegetation Type	Class	Common Name	Scientific Name
Grassland			
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Sand dropseed	Sporobolus crypatandrus
		Galleta grass	Hilaria jamesii
		Blue grama	Bouteloua gracilis
		Needle-and-thread-grass	Stipa comata
	Shrubs	Brigham tea	Ephedra viridis
		Broom snakeweed	Gutierrezia sarothrae
		Yucca	Yucca Baileyi
		Pillar vanclevea	Vanclevea stylosa
		Small rabbitbrush	Chrysothamnus viscidiflorus
	Forbs	Globemallow	Sphaeralcea spp.
		Common borage	Cryptantha spp.
		Lupine	Lupinus pusillus
		Locoweed	Astragulus spp.
Salt Desert Shrub			
	Shrub	Shadscale	Atriplex confertifolia
		Mat saltbush	Atriplex corrugata
		Spined sagebrush	Artemisia spinescens
	grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
	forbs	Globemallow	Sphaeralcea coccinea
		Russian thistle	Salsola kali
Pinyon-juniper			
	Trees	Utah juniper	Juniperus osteosperma
		Double leaf pinyon	Pinus edulis
	Shrubs	Buffalo berry	Shepherdia rotunifolia
		Brigham tea	Ephedra viridis
		Cliffrose	Cowania mexicana
		Yucca	Yucca baileyi
		Bitterbrush	Purshia tridentata
		Cacti	Opuntia polyacantha
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Blue grama	Bouteloua gracilis
		Sand dropseed	Sporobolus cryptandrus
		Galleta grass	Hilaria jamesii
	Forbs	Globe mallow	Sphaeralcea coccinea
		Pepperweed	Lepidium spp.
		Common borage	Cryptantha spp.
		Lupine	Lupinus spp.
		Misc. annuals	

(continued)

FIGURE 2

Common Species Ranked by Average Relative Importance

Vegetation Type	Class	Common Name	Scientific Name
Mixed Desert Shrub			
	Shrubs	Blackbrush	Coleogyne ramosissima
		Spiny hopsage	Grayia spinosa
		Wolfberry	Lycium andersonii
		Brigham tea	Ephedra viridis
		Small rabbitbrush	Chrysothamnus viscidiflorus
	Grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
		Blue grama	Bouteloua gracilis
	Forbs	Globemallow	Sphaeralcea coccinea
		Common borage	Cryptantha spp.
		Pepperweed	Lepidium montanum
		Lupine	Lupinus spp.
Sagebrush	Shrubs	Big sagebrush	Artemisia tridentata
		Small rabbitbrush	Chrysothamnus viscidiflorus
		Broom snakeweed	Gutierrezia sarothrae
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Galleta grass	Hilaria jamesii
		Blue grama	Bouteloua gracilis
		Needle-and-thread-grass	Stipa comata
	Forbs	Globemallow	Sphaeralcea coccinea
		Lupine	Lupinus spp.
		Common borage	Cryptantha spp.
		Misc. annuals	

APPENDIX II-9

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

APPENDIX II - 9

Vegetation

Transmission system impact area

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
Juniper-pinyon Woodland	Grass	Blue grama	Bouteloua gracilis
		Arizona fescue	Festuca arizonica
	Forbs	Globe mallow	Sphaeralcea coccinea
		Borage	Cryptantha sp.
		Lupine	Lupinus sp.
		Pepper weed	Lepidium sp.
	Shrubs	Sagebrush	Artemisia tridentata
		Black sagebrush	Artemisia nova
		Cliff rose	Cowania mexicana
		Snakeweed	Gutierrezia sarothrae
		Algerita	Berberis fremonti
		Serviceberry	Amelanchier alnifolia
		Brigham tea	Ephedra sp.
		Bitterbrush	Purshia tridentata
	Trees	Colorado pinyon	Pinus edulis
		Utah juniper	Juniperus osteosperma
		One-seed juniper	Juniperus monosperma
		Single-leaf pinyon	Pinus monophylla
		Rocky Mountain juniper	Juniperus scopulorum
Plains and Desert Grassland	Grass	Blue grama	Bouteloua gracilis
		Black grama	Bouteloua eriopoda
		Hairy grama	Bouteloua hirsuta
		Sideoats grama	Bouteloua curtipendula
		Tobosa grass	Hilaria mutica
		Galleta grass	Hilaria jamesii
		Three awn	Aristida spp.
		Needle and thread grass	Stipa spp.
		Sand dropgrass	Sporobolus cryptandrus
		Indian ricegrass	Oryzopsis hymenoides
		Sand bluestem	Andropogon halli
		Little bluestem	Andropogon scoparius
		Love grass	Eragrostis spp.
		Bush muhly	Muhlenbergia porteria

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
	Forbs	Globe mallow	Sphaeralcea spp.
		Lupine	Lupinus spp.
		Locoweed	Astragulus spp.
	Shrubs	Velvet mesquite	Prosopis juliflora
		Cat claw	Acacia greggi
		Little rabbitbrush	Chrysothamnus viscidiflorus
		Four-wing saltbush	Atriplex canescens
		Burroweed	Haplopappus spp.
		Snakeweed	Gutierrezia sarothrae
		Cane cholla	Opuntia spinosior
		Buckhorn cholla	Opuntia spp.
		Prickly pear	Opuntia spp.
		Palmilla	Yucca elata
		Sotol	Dasylirion wheeleri
Great Basin desert scrub	Grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
		Indian grass	Sorghastrum nutrans
		Salt grass	Distichilis stricta
		Blue grama	Bouteloua gracilis
		Sand dropseed	Sporobolus cryptandrus
	Forbs	Globe mallow	Sphaeralcea coccinea
		Pickle weed	Allenrolfea occidentalis
		Russian thistle	Salsola kali
	Shrubs	Sagebrush	Artemisia tridentata Artemisia nova
		Blackbrush	Coleogyne ramosissima
		Shadscale	Atriplex confertifolia
		Horse brush	Tetradymia canescens
		Winter fat	Eurotia lanata
		Mormon tea	Ephedra viridis
		Greasewood	Sarcobatus vermiculatus
		Honey mesquite	Prosopis juliflora
		Pale lycium	Lycium pallidum
Mohave desert scrub	Grass	Galleta grass	Hilaria jamesii
		Big galleta	Hilaria rigidia
	Forbs	Desert trumpet	Eriogonum inflatum
	Shrubs	Mohave yucca	Yucca mohavensis
		Banana yucca	Yucca baccata
		Brittle brush	Encelia farinosa
		Creosote bush	Larrea divaricata
		Gray Krameria	Krameria grayi

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
	Shrubs	Cheese bush	Hymenoclea salsola
		White bursage	Ambrosia (Franseria) dumosa
		Woolly bursage	Ambrosia (Franseria) eriocentra
		Goldenhead	Acamtopappus sphaerocephalus
		Bladder sage	Salazaria mexicana
		Blackbrush	Coleogyne ramosissima
		Mormon tea	Ephedra spp.
		Winterfat	Eurotia lanata
		California buckwheat	Eriogonum fasciculatum
		Mohave sage	Salvia mohavensis
		Cat claw	Acacia greggi
		Mesquite	Prosopis juliflora
		Barrel cactus	Ferocactus wislizeni
		Cholla	Opuntia spp.
		Palo verde	Cercidium floridum
		Ocotillo	Fouquieria splendens
	Trees	Joshua tree	Yucca brevifolia
Coastal sage Scrub	Grass	Mediterranean grass	Schismus barbatus
		Wild oats	Avena barbata
		Brome grass	Bromus spp.
	Forbs	Filaree	Erodium cicutarium
		Mustard	Brassica spp.
	Shrubs	California buckwheat	Eriogonum fasciculatum
		California sagebrush	Artemisia californica
		White sage	Salvia apiana
		Black sage	Salvia mellifera
		Brittle brush	Encelia farinosa
Coastal Chaparral	Grass	Wild oats	Avena barbata
	Shrubs	Chamise	Adenostoma fasciculatum
		Manzanita	Arctostaphylos spp.
		California lilac	Ceanothus spp.
		Birch-leaf mountain mahogany	Cercocarpus betuloides
		Holly-leaf cherry	Prunus ilicifolia
		Scrub oak	Quercus dumosa
		Poison oak	Rhus diversiloba
		Sugar bush	Rhus ovata
		Spanish bayonet	Yucca whipplei

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
		California buckwheat	Eriogonum fasiculatum
		Brittle bush	Encelia farinosa
		Lemonade berry	Rhus integifolla
		Mustard	Brassica spp.
		Black sage	Salvia mellifera
Riparian Deciduous Woodland	Shrubs	Apache plume	Fallugia paradoxa
		Poison oak	Rhus diversiloba
		Blueberry elder	Sambucus glauca
		Oak	Quercus spp.
		Honey mesquite	Prosopis juliflora
		Cat claw	Acacia greggi
		Chokecherry	Prunus spp.
		Skunk bush	Rhus trilobata
		Tamarisk	Tamarix pentata
	Trees	Rocky Mountain maple	Acer glabrum
		Box elder	Acer negundo
		Arizona alder	Alnus oblongifolia
		Alders	Alnus spp.
		Walnut	Juglans major
		Ash	Fraxinus spp.
		Mulberry	Morus microphylla
		Sycamore	Platanus wrightii
		Narrow-leaf cottonwood	Populus angustifolia
		Fremont cottonwood	Populus fremontii
		Quaking aspen	Populus tremuloides
		Willow	Salix spp.
Interior Chaparral	Shrubs	Cliffrose	Cowania mexicana
		Apache-plume	Fallugia paradoxa
		Rosewood	Vauguelinia california
		Mountain mahogany	Cercocarpus spp.
		Buckthorn	Thamnus spp.
		Buckbrush	Ceanothus fendleri
		New Mexico locust	Robinia neomexicana
		Agave	Agave spp.
		Sotol	Nolina wheeleri
		Yucca	Yucca spp.
		Sumac	Rhus spp.
		Poison oak	Rhus diversiloba
		Red mahonia	Berberis spp.
		Brickel bush	Brickellia california
		Viscid rabbitbrush	Chrysothanmus viscidiflorus
		Turpentine brush	Haplopappus laricifolius
		Manzanita	Arctostaphylos spp.

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
		Oak	Quercus spp.
		Silk-tassel	Garrya spp.
		Mountain balm	Eriodictyon angustifolium
		Feather dalea	Dalea formosa
		Wistizenius dalea	Dalea wislizeri
	Trees	Arizona cypress	Cupressus arizonica
		Arizona bark juniper	Juniperus deppeana
Sonoran Desert scrub (Arizona Upland Subdivision)	Grass	Spider grass	Aristida ternipes
		Desert fluff grass	Tridens pulchellus
		Bush muhly	Muhlenbergia porteri
	Forbs	Wild buckwheat	Eriogonum spp.
		Indian mallow	Abutilon incanum
	Shrubs	Creosote bush	Larrea divaricata
		Brittle bush	Encelia farinosa
		Navajo ephedra	Ephedra veridis
		Rabbit brush	Chrysothamnus spp.
		Prickly pear cactus	Opuntia phaeocantha
		Cactus	Echinocereus spp.
		Barrel cactus	Ferocactus spp.
		Fishhook cactus	Mammillaria microcarpus
		Cholla	Opuntia spp.
		Range ratany	Krameria grayius
		Desert thorn	Lycium andersoni
		Ocotillo	Fouquieria splendens
	Trees	Ironwood	Olneya tesota
		Saguaro	Cereus giganteus
		Foothill palo verde	Cercidium microphyllum
Sonoran Desert Scrub (Lower Colorado Subdivision)			
	Grass	Bush muhly	Muhlenbergia porteri
		Desert fluff grass	Tridens pulchellus
		Big galleta grass	Hilaria rigida
	Forbs	Quelite-salado	Suaeda torreyana
		Iodine-bush	Allenrolfea occidentalis
	Shrubs	Night-blooming cereus	Cereus greggi
		Barrel cactus	Echinocereus fendleri
		Fishhook cactus	Mammillaria fasciculata
		Staghorn cholla	Opuntia versicolor
		White bursage	Ambrosia dumosa
		Desert zinnia	Zinnia pumila
		Mormon tea	Ephedra trifurca
		Creosote bush	Larrea divaricata

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
Desert Wash Community	Shrubs & Trees	Cat claw	Acacia greggi
		Desert willow	Chilopsis linearis
		Desert ironwood	Olney tesota
		Smoke tree	Dalea spinosa
		Palo verde	Cercidium floridum
Alkali Sink Community	Forbs	Seepweed	Suaeda spp.
		Pickleweed	Salicornia spp.
		Iodine bush	Allenrolfea occidentalis
	Shrubs	Saltbush	Atriplex spp.
Joshua Tree Woodland	Grass	Galleta grass	Hilaria jamesii
		Big galleta grass	Hilaria rigida
		Bush muhly	Muhlenbergia porteri
	Forbs	Globe mallow	Sphaeralcea coccinea
		Filaree	Erodium cicutariun
	Shrubs	Creosote bush	Larrea divaricata
		White bursage	Ambrosia dumosa
		Yucca	Yucca schidigera
		Mohave yucca	Yucca mohavensis
		Cheese bush	Hymenoclea salsola
		Bladder sage	Salazaria mexicana
	Trees	Joshua tree	Yucca brevifolia

APPENDIX II-10

Vegetative Communities

APPENDIX II - 10

Vegetation

Transmission system impact area

Vegetative communities

Pinyon-juniper woodland

Juniper (cedar) is more prevalent along this section than pinyon pine. It reaches its greatest development on plateaus and mesas at elevations between 5,500 and 7,500 feet. Below 6,000 feet the woodland is often characterized by juniper in pure stands. This woodland occurs on highly varied soils, from rocky to sandy and shallow to deep. Junipers have extended widely into former range grasslands during the past 100 years. The juniper to pinyon ratio is about three to two in this vegetative community. Colorado pinyon (Pinus edulis) is the common and characteristic pinyon species. Singleleaf pinyon (Pinus monophylla) occurs locally with Utah juniper. Utah juniper (Juniperus osteosperma) and one-seed juniper (Juniperus monosperma) are the common and widespread juniper species.

The understory is either grassland or desert scrub. Grasses were historically more abundant. Many weed and shrub plants have replaced grasses in the understory where overgrazing has been severe.

Great Basin Desert scrub

This shrub-dominated and relatively simple structured desert scrub of the Great Basin "cold desert" is characterized by low plant species diversity, many of which are specialized for salt and cold tolerance. Several of the plant dominants such as sagebrush (Artemisia tridentata), blackbrush (Coleogyne ramosissima) and shadscale (Atriplex confertifolia) occur in essentially pure shrub stands. This type grows between 3,000 and 6,500 feet elevation, with most of it above 4,000 feet.

Mohave Desert Scrub

This type is situated for ecological reasons between the colder Great Basin desert scrub on the north and the warmer Sonoran desert scrub on the south. Mohave desert scrub is found between approximately 800 and 5,200 feet, mostly between 1,000 and 4,000 feet. High aridity with relative lack of summer rains, and long periods of below freezing winter temperatures combine to make the Mohave Desert poor in plant life.

Creosote bush (Larrea divaricata) and white bursage, (Ambrosia dumosa) dominate extensive areas. Bladder sage (Salazaria mexicana) is a prominent shrub that is almost wholly confined to this type. Mohave sage (Salvia mohavensis) and wooly bursage (Ambrosia eriocentra) are near-endemic shrubby species in the Mohave desert scrub community. The Joshua tree (Yucca brevifolia) is an endemic tree yucca that forms extensive "forests" or "woodlands" associated with various shrubby species such as creosote bush, bladder sage, goldenhead (Acamptopappus sphaerocephalus), winter-fat (Eurotia lanata) and black brush. Mohave yucca (Yucca mohavensis) and banana yucca (Yucca baccata) are interspersed with Joshua trees. Cat claw (Acacia greggi) and mesquite (Prosopis juliflora) are found in the washes. For purposes of this statement, the Joshua tree woodland association has been separated from this community and is discussed as a separate community.

The creosote bush scrub association covers most of the California deserts. It is composed of low growing shrubs one to five feet tall. Areas with low moisture have sparse vegetation and are often composed solely of creosote bush and occasional annuals. Areas of higher moisture often contain large amounts of blackbrush. The creosote bush-cheese bush (Hymemoclea salsola) association is the dominant vegetation of Mohave desert scrub communities along the proposed powerline route.

The octotillo (Fouqieria splendens)-palo verde (cericidium floridum) - Cat claw association is uncommon to the Mohave desert scrub community and is confined to a few more arid areas.

Desert wash association

The desert wash association is found along washes and dry stream beds throughout the desert. Water supply is adequate to support this vegetation. In some areas, the vegetation is sparse and stunted. In other areas, the vegetation is dense with palo verde, smoke trees (Dalea spinosa) and desert ironwood trees (Olneya tesota) reaching 10 to 20 feet high.

Alkaline sink vegetative association

Alkaline sink vegetation is restricted to low spots where water collects and evaporates, leaving high concentrations of salts. These plants are adapted to alkaline soils. Vegetation is extremely sparse with large amounts of exposed soil.

Plains and desert grassland

This grassland type is unique because grasses are comingled with various woody shrubs. Lower elevational limit of the desert grassland transition is about 3,500 feet, and it ordinarily prevails to approximately 5,000 feet. It occurs on the desert in local areas where soil-type factors increase the plant-available soil moisture. Thus, it can exist in areas which receive as little as six to seven inches average annual precipitation, which is well below the ordinary lower limit of 10 to 11 inches for desert grassland.

Coastal sage scrub

Coastal sage scrub is an open shrub community, with shrubs reaching five feet in height but infrequently growing together to form a closed canopy. Open areas are covered by forbs and grasses, leaving little bare ground. This plant community is found at elevations below the more dense chaparral. In recent years, much clearing has taken place. It has been subject to grazing and is now becoming dominated by introduced grasses and forbs. The amount of coastal sage scrub in southern California has dwindled in the last 50 years due to the ease with which it can be cleared. Agricultural and urban growth has extended into these areas.

Coastal chaparral

This chaparral plant community is composed of evergreen shrubs three to 10 feet high. Vegetation is usually very dense and often difficult to walk through. Only at the edges or in places where the canopy opens and allows light to reach the soil are high densities of forbs and grasses found. Prior to man's fire prevention practices, chaparral was subject to burning every 20 to 40 years. Plants have adapted and if regular burning does not occur, succession to an oak woodland type will take place where soil and moisture conditions are proper. Burning is necessary to maintain chaparral in its prime condition. Modern management practices use chaining and other clearing methods in place of fire.

Chamise chaparral is intermediate between coastal sage scrub and chaparral is open in some areas and very dense in others. Fire is an important factor in its ecology as in chaparral. Chamise chaparral is decreasing in abundance due to the ease with which it can be cleared for agricultural and urban uses. This chaparral type has been incorporated into the coastal chaparral community.

Interior chaparral

Interior chaparral occurs in the central part of Arizona, usually between 4,000 and 6,000 feet, and as high as 7,000 feet. Precipitation ranges from approximately 13 to 23 inches annually. Chaparral in Arizona is characterized by dense shrubby growth and fairly uniform heights between three and six or seven feet, broken by an occasional taller pinyon, juniper or Arizona cypress (Cypressus arizonica).

The dominant plants are generally tough-leaved, evergreen shrubs. Scrub oak is by far the most common dominant, accounting for over 90 percent of the stand in many areas. Several dozen other shrubby plant species are typically found in mature stands of chaparral, such as buckthorn (Thamnus spp.), mountain-mahogany (Cerocarpus spp.), manzanita (Arctostaphylos spp.), yucca, some juniper, oak (Quercus spp.) and cactus (Opuntia) species.

Density and distribution of grasses in Arizona chaparral are governed by shrub density; the more dense the chaparral, the fewer grasses.

Pockets of Encinal oak-pine woodland occur through the interior chaparral biome as far north as the Mogollon Rim. They are not extensive enough to be identified as a separate biome in the study area; however, species such as Emory (Quercus emoryi), Mexican blue (Q. oblongifolia), Arizona (Q. oblongifolia), Arizona (Q. arizonica) and gray (Q. grisea) oaks, alligator (Juniperus deppenana) and other junipers, a small stand of Arizona cypress and shrubs common to the oak-woodland biome can be found.

Sonoran desert scrub

Sonoran desert scrub extends for many unbroken miles across Arizona. In the southern part of the state the proposed transmission line crosses two major desert scrub biotic communities: the shrub-form palo verde-saguaro or palo verde-cactus communities (Arizona upland subdivision). Also involved may be the more restricted saltbush desert thorn community found within the lower Colorado subdivision.

Desert scrub found in the study area and along the proposed route tends to be reasonably stable under the existing climate. The environment is especially harsh; species makeup is exclusive, and the same species are both pioneer and climax plants in the desert scrub non-succession. Thus, Sonoran desert scrub, in most areas, is the least sensitive community to be crossed by the powerline.

Sonoran desert scrub (Arizona upland)

Palo verde-saguro (Cereus giganteus) or palo verde-cactus community is characteristic of the Arizona upland subdivision. It is the most lush and most diverse desert community in the United States, often containing more than 100 native desert plants in any one of the various local habitats. This figure may be compared to a similar size area in the creosote bush or saltbush desert communities where three or four species are typically found.

Typical plants in palo verde-saguaro are foothill palo verde (Cercidum microphyllum), saguaro, and numerous species of smaller cacti. Desert thorn (Lycium andersoni), Indian mallow (Abutilon incanum), ocotillo, ironwood, brittle-bush (Encelia furinosa), and bush muhly (Muhlenbergia porteri) are also commonly encountered. In addition to the above perennials. Many species of small annuals may be added which bloom only after summer rains. The best developed palo verde-saguaro stands are generally restricted to small concentrated areas.

Sonoran desert scrub (lower Colorado)

Vegetation of this major subdivision of the Sonoran desert is dominated by creosote bush and its major associate, white bursage. In local situations such as river flood plains and low undrained areas within valleys and basins, communities of saltbush, desert thorn and mesquite commonly dominate, often to the total exclusion of creosote bush and bursage.

Both creosote bush-bursage and salt bush desert thorn communities have few species, at least in comparison with others thus far discussed. Roughly ten species, such as creosote bush, white bursage, and several species of cacti, may be found in the former, while only six are characteristic of the latter.

In addition to the above desert communities, another quite different plant assemblage may be found growing along arroyos and large washes in the desert. These desert "riparian" species include white thron, cat claw, mesquite, and occasionally blue palo verde. These species, in association with several other small shrubs, often form a distinct fingerlike riparian association well into the desert where elements of the riparian woodland fail to penetrate. Under very dry conditions, in areas receiving less than six inches of rainfall, even the upland climax dominants such as saguaros and palo verdes may be found more or less restricted to such riparian habitats.

Riparian deciduous woodland

Riparian woodlands occur along perennial and intermittent streams and rivers. Quality of this type of vegetation depends heavily upon water availability. Where water is readily available year-round, riparian growth may be very dense. Where only intermittent water is available, riparian woodlands tend to be less well developed and may, in fact, be dominated by vegetation more characteristic of surrounding areas.

These are very sensitive communities, restrictive as to area and remnants of earlier widespread forests. This biome has definite plant successional stages (steps to a stable condition), and these present communities are generally in their climax, or final state. If disturbed, it would take a number of years, if ever, before the area would return to the same condition.

Species composition of riparian woodlands changes with altitude and location. On the Colorado Plateau, in the vicinity of the Little Colorado River, Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spp.) are dominant. Characteristics of this area are governed by Great Basin desert scrub and grassland with elements of both communities commonly found close to waterways vegetation.

Riparian communities

In areas of springs, seeps, washes and marshes, typical vegetation consists of rushes, bullrushes, copperweed, and rabbitsfoot grass. The sediment bars along major channels support luxuriant vegetation such as skunkbush (*Rhus trilobata*), Apache plume (*Fallugia paradoxa*), and tamarisk (*Tamarix pentata*).

Joshua tree woodland

This community was taken out of the Mohave desert scrub community as described by Lowe and Brown in "The Natural Vegetation of Arizona," and is treated as a separate community. Joshua trees are dense in some areas and have the appearance of a woodland type. In other areas they are scattered and are classed in the Mohave desert scrub community.

Most of this community lies between 2,500 and 4,000 feet elevation. Annual precipitation varies between eight and 11 inches. Vegetation is similar to the higher elevations of the Mohave desert scrub type described above.

Urban agricultural

These are lands that are presently being used or developed for agriculture or expansion of urban areas. Small areas of undisturbed coastal sage and coastal chaparral are found within this description.

Besides the biotic communities listed above, there are two categories of rangeland that warrant discussion. They are wasteland and barren ground. The wasteland category is used to classify all steep and rocky areas where vegetative ground cover still exceeds two percent. It usually consists of shallow soils that are very sparsely vegetated. The barren category is used to identify rangeland which contains less than two percent vegetative ground cover. This type often occurs as rock outcrops and saline flats. These types are usually small local areas and are not delineated on the map.

APPENDIX II-11

Endangered or Threatened Plant Species Possibly Occurring in Proposed Transmission Corridors in Southern Utah and Northern Arizona

APPENDIX II-11

Endangered or Threatened Plant Species Possibly Occurring in Proposed Transmission Corridors in Southern Utah and Northern Arizona

Family	Genus	Species
Asteraceae	Hymenopappus	filifolius var. tomentosus
Boraginaceae	Cryptantha	semiglabra
Cactaceae	Echinocereus	englmannii var. purpurens
	Echinocactus	xeranthemoides
	Ferocactus	acanthodes
	Mammillaria	tetrancistra
	Opuntia	pulchella
	Opuntia	whipplei var. multigeniculata
	Pediocactus	sileri
	Sclerocactus	pubispinus var. sileri
Fabaceae	Astragalus	ensiformis
	Astragalus	lancearius
	Astragalus	minthorniae var. gracilioe
	Astragalus	tephrodeus var. brachylobus
	Peteria	thompsoniae
	Psoralea	castorea
Hydrophyllaceae	Phacelia	constancei

APPENDIX II-12

Endangered and Threatened Plant Species of the Affected States

APPENDIX II-12

Endangered and Threatened Plant Species of the Affected States

A report on endangered and threatened plant species of the United States was presented to the Congress by the Smithsonian Institution. Their report lists the following plants as either endangered or threatened within the states that the proposed transmission line would pass through. The plants are listed by states. Some of these plant species could possibly be found within or near the proposed transmission line corridors.

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
ARIZONA	ENDANGERED	ANACARDIACEAE	RHUS KEARNEYI
ARIZONA	ENDANGERED	APOCYNACEAE	AMSONIA KEARNEYANA
ARIZONA	ENDANGERED	ASTERACEAE	ERIGERON ERIOPHYLLUS
ARIZONA	ENDANGERED	ASTERACEAE	ERIGERON KUSCHEI
ARIZONA	ENDANGERED	ASTERACEAE	ERIGERON RELIGIOSUS
ARIZONA	ENDANGERED	ASTERACEAE	GALINSOGA SEMICALVA VAR. PERCALVA
ARIZONA	ENDANGERED	ASTERACEAE	HAPLOPAPPUS SALICINUS
ARIZONA	ENDANGERED	ASTERACEAE	MACHAERANTHERA ARIZONICA
ARIZONA	ENDANGERED	ASTERACEAE	PECTIS RUSBYI
ARIZONA	ENDANGERED	ASTERACEAE	PERITYLE GILENSIS VAR. SALENSIS
ARIZONA	ENDANGERED	ASTERACEAE	PLUMMERA AMBIGENS
ARIZONA	ENDANGERED	ASTERACEAE	SENECIO FRANCISCANUS
ARIZONA	ENDANGERED	ASTERACEAE	STEPHANOMERIA SCHOTTII
ARIZONA	ENDANGERED	BERBERIDACEAE	BERBERIS HARRISONIANA
ARIZONA	ENDANGERED	BORAGINACEAE	CRYPTANTHA ATWOODII
ARIZONA	ENDANGERED	BRASSICACEAE	DRABA ASPRELLA VAR. ASPRELLA
ARIZONA	ENDANGERED	BRASSICACEAE	DRABA ASPRELLA VAR. KAIBABENSIS
ARIZONA	ENDANGERED	BRASSICACEAE	SISYMBRIUM KEARNEYI
ARIZONA	ENDANGERED	BRASSICACEAE	STREPTANTHUS LEMMONII
ARIZONA	ENDANGERED	CACTACEAE	ECHINOCACTUS HORIZONTHALONIUS VAR. NICHOLII
ARIZONA	ENDANGERED	CACTACEAE	ECHINOCEREUS TRIGLOCHIDIATUS VAR. ARIZONICUS
ARIZONA	ENDANGERED	CACTACEAE	OPUNTIA BASILARIS VAR. TRELEASEI
ARIZONA	ENDANGERED	CACTACEAE	PEDIOCACTUS BRADYI
ARIZONA	ENDANGERED	CACTACEAE	PEDIOCACTUS PEEBLESIANUS VAR. PEEBLESIANUS
ARIZONA	ENDANGERED	CACTACEAE	PEDIOCACTUS SILERI
ARIZONA	ENDANGERED	CARYOPHYLLACEAE	SILENE RECTIRAMEA
ARIZONA	ENDANGERED	CHENOPODIACEAE	ATRIPLEX GRIFFITHSII
ARIZONA	ENDANGERED	CONVOLVULACEAE	IPOMOEA EGREGIA
ARIZONA	ENDANGERED	CONVOLVULACEAE	IPOMOEA LEMMONI
ARIZONA	ENDANGERED	CRASSULACEAE	ECHEVERIA COLLOMAE
ARIZONA	ENDANGERED	CRASSULACEAE	ECHEVERIA RUSBYI
ARIZONA	ENDANGERED	CYPERACEAE	CAREX SPECUICOLA
ARIZONA	ENDANGERED	FABACEAE	ASTRAGALUS BEATHII
ARIZONA	ENDANGERED	FABACEAE	ASTRAGALUS CREMNOPHYLAX
ARIZONA	ENDANGERED	FABACEAE	ASTRAGALUS LENTIGINOSUS VAR. MARICOPAE
ARIZONA	ENDANGERED	FABACEAE	ASTRAGALUS XIPHOIDES
ARIZONA	ENDANGERED	FABACEAE	SOPHORA FORMOSA
ARIZONA	ENDANGERED	HYDROPHYLLACEAE	PHACELIA FILIFORMIS
ARIZONA	ENDANGERED	HYDROPHYLLACEAE	PHACELIA WELSHII
ARIZONA	ENDANGERED	LILIACEAE	AGAVE ARIZONICA
ARIZONA	ENDANGERED	LILIACEAE	AGAVE MCKELVEYANA
ARIZONA	ENDANGERED	LILIACEAE	AGAVE SCHOTTII VAR. TRELEASEI
ARIZONA	ENDANGERED	LOASACEAE	MENTZELIA NITENS VAR. LEPTOCAULIS
ARIZONA	ENDANGERED	MALVACEAE	SPHAERALCEA FENDLERI VAR. ALBESCENS
ARIZONA	ENDANGERED	NYCTAGINACEAE	ALLIONIA CRISTATA
ARIZONA	ENDANGERED	OLEACEAE	FRAXINUS GOODDINGII
ARIZONA	ENDANGERED	ONAGRACEAE	CAMISSONIA SPECUICOLA SSP. SPECUICOLA
ARIZONA	ENDANGERED	PAPAVERACEAE	ARCTOMECON HUMILIS
ARIZONA	ENDANGERED	POACEAE	SPOROBOLUS PATENS
ARIZONA	ENDANGERED	POLYGONACEAE	ERIOGONUM CAPILLARE
ARIZONA	ENDANGERED	POLYGONACEAE	ERIOGONUM DARROVII
ARIZONA	ENDANGERED	POLYGONACEAE	ERIOGONUM MORTONIANUM
ARIZONA	ENDANGERED	POLYGONACEAE	ERIOGONUM THOMPSONAE VAR. ATWOODII
ARIZONA	ENDANGERED	POLYGONACEAE	ERIOGONUM ZIONIS VAR. COCCINEUM
ARIZONA	ENDANGERED	POLYGONACEAE	RUMEX ORTHONEURUS
ARIZONA	ENDANGERED	PRIMULACEAE	PRIMULA HUNNEWELLII
ARIZONA	ENDANGERED	RANUNCULACEAE	RANUNCULUS INAMOENUS VAR. SUBAFFINIS
ARIZONA	ENDANGERED	ROSACEAE	COWANIA SUBINTEGRA
ARIZONA	ENDANGERED	RUBIACEAE	GALIUM COLLOMAE
ARIZONA	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA CRUENTA
ARIZONA	ENDANGERED	SCROPHULARIACEAE	LIMOSELLA PUBIFLORA
ARIZONA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON CLUTEI
ARIZONA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON DISCOLOR
ARIZONA	ENDANGERED	SOLANACEAE	MARGARANTHUS LEMMONII
ARIZONA	THREATENED	APIACEAE	CYMOPTERUS NEWBERRYI
ARIZONA	THREATENED	APOCYNACEAE	AMSONIA PALMERI
ARIZONA	THREATENED	APOCYNACEAE	AMSONIA PEEBLESII
ARIZONA	THREATENED	ASCLEPIADACEAE	ASCLEPIAS CUTLERI
ARIZONA	THREATENED	ASTERACEAE	ASTER LEMMONII
ARIZONA	THREATENED	ASTERACEAE	ENCELIA FRUTESCENS VAR. RESINOSA
ARIZONA	THREATENED	ASTERACEAE	ERIGERON ARIZONICUS
ARIZONA	THREATENED	ASTERACEAE	ERIGERON LEMMONII
ARIZONA	THREATENED	ASTERACEAE	ERIGERON LOBATUS
ARIZONA	THREATENED	ASTERACEAE	ERIGERON PRINGLEI
ARIZONA	THREATENED	ASTERACEAE	GUTIERREZIA LINOIDES
ARIZONA	THREATENED	ASTERACEAE	HAPLOPAPPUS SCOPULORUM
ARIZONA	THREATENED	ASTERACEAE	HELENIUM ARIZONICUM
ARIZONA	THREATENED	ASTERACEAE	HYMENOXYS QUINQUESQUAMATA
ARIZONA	THREATENED	ASTERACEAE	HYMENOXYS SUBINTEGRA
ARIZONA	THREATENED	ASTERACEAE	MACHAERANTHERA MUCRONATA
ARIZONA	THREATENED	ASTERACEAE	PERITYLE COCHISENSIS
ARIZONA	THREATENED	ASTERACEAE	PERITYLE LEMMONII
ARIZONA	THREATENED	ASTERACEAE	PERITYLE SAXICOLA
ARIZONA	THREATENED	ASTERACEAE	PLUMMERA FLORIBUNDA
ARIZONA	THREATENED	ASTERACEAE	SENECIO CARDAMINE
ARIZONA	THREATENED	ASTERACEAE	TAGETES LEMMONII
ARIZONA	THREATENED	BORAGINACEAE	CRYPTANTHA SEMIGLABRA
ARIZONA	THREATENED	BRASSICACEAE	ARABIS GRACILIPES
ARIZONA	THREATENED	BRASSICACEAE	DRABA ASPRELLA VAR. STELLIGERA
ARIZONA	THREATENED	BRASSICACEAE	LESQUERELLA GOODDINGII
ARIZONA	THREATENED	CACTACEAE	CORYPHANTHA RECURVATA
ARIZONA	THREATENED	CACTACEAE	CORYPHANTHA SCHEERI VAR. ROBUSTISPINA
ARIZONA	THREATENED	CACTACEAE	CORYPHANTHA VIVIPARA VAR. ALVERSONII

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
ARIZONA	THREATENED	CACTACEAE	CORYPHANTHA VIVIPARA VAR. ROSEA
ARIZONA	THREATENED	CACTACEAE	ECHINOCEREUS LEDINGII
ARIZONA	THREATENED	CACTACEAE	FEROCACTUS ACANTHODES VAR. EASTWOODII
ARIZONA	THREATENED	CACTACEAE	MAMMILLARIA ORESTERA
ARIZONA	THREATENED	CACTACEAE	MAMMILLARIA THORNBERI
ARIZONA	THREATENED	CACTACEAE	NEOLLOYDIA ERECTOCENTRA VAR. ACUNENSIS
ARIZONA	THREATENED	CACTACEAE	NEOLLOYDIA ERECTOCENTRA VAR. ERECTOCENTRA
ARIZONA	THREATENED	CACTACEAE	OPUNTIA BASILARIS VAR. LONGIAREOLATA
ARIZONA	THREATENED	CACTACEAE	OPUNTIA PHAEACANTHA VAR. FLAVISPINA
ARIZONA	THREATENED	CACTACEAE	OPUNTIA PHAEACANTHA VAR. MOJAVENSIS
ARIZONA	THREATENED	CACTACEAE	OPUNTIA PHAEACANTHA VAR. SUPERBOSPINA
ARIZONA	THREATENED	CACTACEAE	OPUNTIA WHIPPLEI VAR. MULTIGENICULATA
ARIZONA	THREATENED	CACTACEAE	PEDIOCACTUS PAPYRACANTHUS
ARIZONA	THREATENED	CACTACEAE	PEDIOCACTUS PARADINEI
ARIZONA	THREATENED	CACTACEAE	PEDIOCACTUS PEEBLESIANUS VAR. FICKEISENIAE
ARIZONA	THREATENED	CACTACEAE	SCLEROCACTUS SPINOSIOR
ARIZONA	THREATENED	CAPPARIDACEAE	CLEOME MULTICAULIS
ARIZONA	THREATENED	CROSSOSOMATACEAE	CROSSOSOMA PARVIFLORUM
ARIZONA	THREATENED	EUPHORBIACEAE	MANIHOT DAVISIAE
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS AMPULLARIUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS DESPERATUS VAR. CONSPECTUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS ENSIFORMIS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS GEYERI VAR. TRIQUETRUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS LANCEARIUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS LENTIGINOSUS VAR. AMBIGUUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS STRIATIFLORUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS TITANOPHILUS
ARIZONA	THREATENED	FABACEAE	ASTRAGALUS TROGLODYTUS
ARIZONA	THREATENED	FABACEAE	ERRAZURIZIA ROTUNDATA
ARIZONA	THREATENED	FABACEAE	LUPINUS CUTLERI
ARIZONA	THREATENED	FABACEAE	PETERIA THOMPSONIAE
ARIZONA	THREATENED	FABACEAE	PSORALEA EPIPSILA
ARIZONA	THREATENED	FABACEAE	SOPHORA ARIZONICA
ARIZONA	THREATENED	HYDROPHYLLACEAE	NAMA RETRORSUM
ARIZONA	THREATENED	HYDROPHYLLACEAE	PHACELIA CEPHALOTES
ARIZONA	THREATENED	HYDROPHYLLACEAE	PHACELIA CONSTANCEI
ARIZONA	THREATENED	HYDROPHYLLACEAE	PHACELIA HOWELLIANA
ARIZONA	THREATENED	HYDROPHYLLACEAE	PHACELIA RAFAELENSIS
ARIZONA	THREATENED	HYDROPHYLLACEAE	PHACELIA SERRATA
ARIZONA	THREATENED	ISOETACEAE	ISOETES BOLANDERI VAR. PYGMAEA
ARIZONA	THREATENED	LILIACEAE	AGAVE UTAHENSIS VAR. KAIBABENSIS
ARIZONA	THREATENED	LILIACEAE	ALLIUM GOODDINGII
ARIZONA	THREATENED	LILIACEAE	TRITELEIA LEMMONAE
ARIZONA	THREATENED	LORANTHACEAE	ARCEUTHOBIUM APACHENSE
ARIZONA	THREATENED	OLEACEAE	FRAXINUS ANOMALA VAR. LOWELLII
ARIZONA	THREATENED	OLEACEAE	FRAXINUS CUSPIDATA VAR. MACROPETALA
ARIZONA	THREATENED	ONAGRACEAE	CAMISSONIA CONFERTIFLORA
ARIZONA	THREATENED	ONAGRACEAE	CAMISSONIA EXILIS
ARIZONA	THREATENED	ONAGRACEAE	CAMISSONIA PARRYI
ARIZONA	THREATENED	ONAGRACEAE	CAMISSONIA SPECUICOLA SSP. HESPERIA
ARIZONA	THREATENED	PAPAVERACEAE	ARGEMONE ARIZONICA
ARIZONA	THREATENED	PLUMBAGINACEAE	LIMONIUM LIMBATUM
ARIZONA	THREATENED	POACEAE	PUCCINELLIA PARISHII
ARIZONA	THREATENED	POLEMONIACEAE	PHLOX CLUTEANA
ARIZONA	THREATENED	POLEMONIACEAE	PHLOX JONESII
ARIZONA	THREATENED	POLYGALACEAE	POLYGALA PILIOPHORA
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM APACHENSE
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM DENSUM
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM HEERMANNII VAR. SUBRACEMOSUM
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM OVALIFOLIUM VAR. VINEUM
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM RIPLEYI
ARIZONA	THREATENED	POLYGONACEAE	ERIOGONUM THOMPSONAE VAR. THOMPSONAE
ARIZONA	THREATENED	POLYPODIACEAE	CHEILANTHES PRINGLEI
ARIZONA	THREATENED	POLYPODIACEAE	CHEILANTHES PYRAMIDALIS VAR. ARIZONICA
ARIZONA	THREATENED	POLYPODIACEAE	NOTHOLAENA LEMMONII
ARIZONA	THREATENED	PRIMULACEAE	PRIMULA SPECUICOLA
ARIZONA	THREATENED	RANUNCULACEAE	AQUILEGIA DESERTORUM
ARIZONA	THREATENED	RANUNCULACEAE	CIMICIFUGA ARIZONICA
ARIZONA	THREATENED	RANUNCULACEAE	CLEMATIS HIRSUTISSIMA VAR. ARIZONICA
ARIZONA	THREATENED	ROSACEAE	POTENTILLA MULTIFOLIOLATA
ARIZONA	THREATENED	ROSACEAE	ROSA STELLATA
ARIZONA	THREATENED	ROSACEAE	VAUQUELINIA PAUCIFLORA
ARIZONA	THREATENED	RUTACEAE	CHOISYA ARIZONICA
ARIZONA	THREATENED	RUTACEAE	CHOISYA MOLLIS
ARIZONA	THREATENED	SCROPHULARIACEAE	CASTILLEJA KAIBABENSIS
ARIZONA	THREATENED	SCROPHULARIACEAE	PENSTEMON BICOLOR SSP. ROSEUS
ARIZONA	THREATENED	SCROPHULARIACEAE	PENSTEMON VIRGATUS SSP. PSEUDOPUTUS
CALIFORNIA	ENDANGERED	APIACEAE	LOMATIUM RAVENII
CALIFORNIA	ENDANGERED	APIACEAE	SANICULA MARITIMA
CALIFORNIA	ENDANGERED	ASTERACEAE	BLENNOSPERMA BAKERI
CALIFORNIA	ENDANGERED	ASTERACEAE	BLENNOSPERMA NANUM VAR. ROBUSTUM
CALIFORNIA	ENDANGERED	ASTERACEAE	CIRSIUM FONTINALE VAR. FONTINALE
CALIFORNIA	ENDANGERED	ASTERACEAE	CIRSIUM LONCHOLEPIS
CALIFORNIA	ENDANGERED	ASTERACEAE	CIRSIUM RHOTHOPHILUM
CALIFORNIA	ENDANGERED	ASTERACEAE	ERIGERON CALVUS
CALIFORNIA	ENDANGERED	ASTERACEAE	ERIGERON DELICATUS
CALIFORNIA	ENDANGERED	ASTERACEAE	ERIGERON FOLIOSUS VAR. BLOCHMANAE
CALIFORNIA	ENDANGERED	ASTERACEAE	ERIOPHYLLUM LANATUM VAR. HALLII
CALIFORNIA	ENDANGERED	ASTERACEAE	ERIOPHYLLUM MOHAVENSE
CALIFORNIA	ENDANGERED	ASTERACEAE	HAPLOPAPPUS EASTWOODAE
CALIFORNIA	ENDANGERED	ASTERACEAE	HELIANTHUS EXILIS
CALIFORNIA	ENDANGERED	ASTERACEAE	HELIANTHUS NIVEUS SSP. TEPHRODES
CALIFORNIA	ENDANGERED	ASTERACEAE	HEMIZONIA CONJUGENS

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	ENDANGERED	ASTERACEAE	HEMIZONIA FLORIBUNDA
CALIFORNIA	ENDANGERED	ASTERACEAE	HEMIZONIA MINTHORNII
CALIFORNIA	ENDANGERED	ASTERACEAE	HOLOCARPHA MACRADENIA
CALIFORNIA	ENDANGERED	ASTERACEAE	LASTHENIA BURKEI
CALIFORNIA	ENDANGERED	ASTERACEAE	LAYIA DISCOIDEA
CALIFORNIA	ENDANGERED	ASTERACEAE	MICROSERIS LACINIATA SSP. SISKIYOUENSIS
CALIFORNIA	ENDANGERED	ASTERACEAE	PENTACHAETA LYONII
CALIFORNIA	ENDANGERED	ASTERACEAE	PSEUDOBAHIA PEIRSONII
CALIFORNIA	ENDANGERED	ASTERACEAE	SENECIO LAYNEAE
CALIFORNIA	ENDANGERED	ASTERACEAE	TRACYINA ROSTRATA
CALIFORNIA	ENDANGERED	BERBERIDACEAE	BERBERIS NEVINII
CALIFORNIA	ENDANGERED	BERBERIDACEAE	BERBERIS SONNEI
CALIFORNIA	ENDANGERED	BORAGINACEAE	AMSINCKIA GRANDIFLORA
CALIFORNIA	ENDANGERED	BORAGINACEAE	CRYPTANTHA ROOSIORUM
CALIFORNIA	ENDANGERED	BORAGINACEAE	PLAGIOBOTHRYS DIFFUSUS
CALIFORNIA	ENDANGERED	BRASSICACEAE	ARABIS BREWERI VAR. PECUNIARIA
CALIFORNIA	ENDANGERED	BRASSICACEAE	ARABIS MCDONALDIANA
CALIFORNIA	ENDANGERED	BRASSICACEAE	ERYSIMUM CAPITATUM VAR. ANGUSTATUM
CALIFORNIA	ENDANGERED	BRASSICACEAE	ERYSIMUM FRANCISCANUM VAR. FRANCISCANUM
CALIFORNIA	ENDANGERED	BRASSICACEAE	SMELOWSKIA OVALIS SSP. CONGESTA
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS ALBIDUS SSP. ALBIDUS
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS CALLISTUS
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS FARNSWORTHIANUS
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS GLANDULOSUS VAR. HOFFMANII
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS MORRISONII SSP. HIRTIFLORUS
CALIFORNIA	ENDANGERED	BRASSICACEAE	STREPTANTHUS NIGER
CALIFORNIA	ENDANGERED	CACTACEAE	ECHINOCEREUS ENGELMANNII VAR. HOWEI
CALIFORNIA	ENDANGERED	CACTACEAE	FEROCACTUS VIRIDESCENS
CALIFORNIA	ENDANGERED	CACTACEAE	OPUNTIA BASILARIS VAR. TRELEASEI
CALIFORNIA	ENDANGERED	CAMPANULACEAE	CAMPANULA CALIFORNICA
CALIFORNIA	ENDANGERED	CAMPANULACEAE	LEGENERE LIMOSA
CALIFORNIA	ENDANGERED	CARYOPHYLLACEAE	ARENARIA URSINA
CALIFORNIA	ENDANGERED	CARYOPHYLLACEAE	SILENE APERTA
CALIFORNIA	ENDANGERED	CARYOPHYLLACEAE	SILENE MARMORENSIS
CALIFORNIA	ENDANGERED	CELASTRACEAE	FORSELLESIA PUNGENS VAR. GLABRA
CALIFORNIA	ENDANGERED	CHENOPODIACEAE	NITROPHILA MOHAVENSIS
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA BETTINAE
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA CANDELABRUM
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA CYMOSA SSP. MARCESCENS
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA MULTICAULIS
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA NESIOTICA
CALIFORNIA	ENDANGERED	CRASSULACEAE	DUDLEYA STOLONIFERA
CALIFORNIA	ENDANGERED	CRASSULACEAE	PARVISEDUM LEIOCARPUM
CALIFORNIA	ENDANGERED	CUPRESSACEAE	CUPRESSUS GOVENIANA VAR. ABRAMSIANA
CALIFORNIA	ENDANGERED	CUSCUTACEAE	CUSCUTA HOWELLIANA
CALIFORNIA	ENDANGERED	CYPERACEAE	CAREX ALBIDA
CALIFORNIA	ENDANGERED	CYPERACEAE	CAREX TOMPKINSII
CALIFORNIA	ENDANGERED	CYPERACEAE	RHYNCHOSPORA CALIFORNICA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS ANDERSONII VAR. PALLIDA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS AURICULATA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS BAKERI
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS DENSIFLORA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS FRANCISCANA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS GLANDULOSA VAR. CRASSIFOLIA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS GLUTINOSA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS HEARSTIORUM
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS MYRTIFOLIA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS PACIFICA
CALIFORNIA	ENDANGERED	ERICACEAE	ARCTOSTAPHYLOS PUMILA
CALIFORNIA	ENDANGERED	EUPHORBIACEAE	CROTON WIGGINSII
CALIFORNIA	ENDANGERED	EUPHORBIACEAE	EUPHORBIA PLATYSPERMA
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS CLARIANUS
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS JAEGERIANUS
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS JOHANNIS-HOWELLII
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS MONOENSIS
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS RAVENII
CALIFORNIA	ENDANGERED	FABACEAE	ASTRAGALUS TENER VAR. TITI
CALIFORNIA	ENDANGERED	FABACEAE	LATHYRUS HITCHCOCKIANUS
CALIFORNIA	ENDANGERED	FABACEAE	LOTUS ARGOPHYLLUS VAR. ADSURGENS
CALIFORNIA	ENDANGERED	FABACEAE	LOTUS SCOPARIUS SSP. TRASKIAE
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS DURANII
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS GUADALUPENSIS
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS LUDOVICIANUS
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS MILO-BAKERI
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS TIDESTROMII VAR. LAYNEAE
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS TIDESTROMII VAR. TIDESTROMII
CALIFORNIA	ENDANGERED	FABACEAE	LUPINUS TRACYI
CALIFORNIA	ENDANGERED	FABACEAE	TRIFOLIUM AMOENUM
CALIFORNIA	ENDANGERED	FABACEAE	TRIFOLIUM LEMMONII
CALIFORNIA	ENDANGERED	FABACEAE	TRIFOLIUM POLYODON
CALIFORNIA	ENDANGERED	FABACEAE	TRIFOLIUM TRICHOCALYX
CALIFORNIA	ENDANGERED	FUMARIACEAE	DICENTRA FORMOSA SSP. OREGANA
CALIFORNIA	ENDANGERED	FUMARIACEAE	DICENTRA OCHROLEUCA
CALIFORNIA	ENDANGERED	GENTIANACEAE	CENTAURIUM NAMOPHILUM
CALIFORNIA	ENDANGERED	HYDROPHYLLACEAE	ERIODICTYON ALTISSIMUM
CALIFORNIA	ENDANGERED	HYDROPHYLLACEAE	ERIODICTYON CAPITATUM
CALIFORNIA	ENDANGERED	HYDROPHYLLACEAE	PHACELIA COOKEI
CALIFORNIA	ENDANGERED	IRIDACEAE	IRIS TENAX SSP. KLAMATHENSIS
CALIFORNIA	ENDANGERED	JUGLANDACEAE	JUGLANS HINDSII
CALIFORNIA	ENDANGERED	LAMIACEAE	ACANTHOMINTHA ILICIFOLIA
CALIFORNIA	ENDANGERED	LAMIACEAE	ACANTHOMINTHA OBOVATA SSP. DUTTONII
CALIFORNIA	ENDANGERED	LAMIACEAE	MONARDELLA LINOIDES SSP. VIMINEA
CALIFORNIA	ENDANGERED	LAMIACEAE	MONARDELLA MACRANTHA VAR. HALLII

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	ENDANGERED	LAMIACEAE	MONARDELLA PRINGLEI
CALIFORNIA	ENDANGERED	LAMIACEAE	MONARDELLA UNDULATA VAR. FRUTESCENS
CALIFORNIA	ENDANGERED	LAMIACEAE	POGOGYNE ABRAMSII
CALIFORNIA	ENDANGERED	LAMIACEAE	POGOGYNE DOUGLASII SSP. PARVIFLORA
CALIFORNIA	ENDANGERED	LAMIACEAE	SALVIA COLUMBARIAE VAR. ZIEGLERI
CALIFORNIA	ENDANGERED	LAMIACEAE	SALVIA GREATAE
CALIFORNIA	ENDANGERED	LAMIACEAE	TRICHOSTEMA AUSTROMONTANUM SSP. COMPACTUM
CALIFORNIA	ENDANGERED	LILIACEAE	ALLIUM HICKMANII
CALIFORNIA	ENDANGERED	LILIACEAE	BRODIAEA CORONARIA VAR. ROSEA
CALIFORNIA	ENDANGERED	LILIACEAE	BRODIAEA FILIFOLIA
CALIFORNIA	ENDANGERED	LILIACEAE	BRODIAEA ORCUTTII
CALIFORNIA	ENDANGERED	LILIACEAE	BRODIAEA PALLIDA
CALIFORNIA	ENDANGERED	LILIACEAE	CALOCHORTUS CLAVATUS SSP. RECURVIFOLIUS
CALIFORNIA	ENDANGERED	LILIACEAE	CALOCHORTUS COERULEUS VAR. WESTONII
CALIFORNIA	ENDANGERED	LILIACEAE	CALOCHORTUS TIBURONENSIS
CALIFORNIA	ENDANGERED	LILIACEAE	CHLOROGALUM GRANDIFLORUM
CALIFORNIA	ENDANGERED	LILIACEAE	CHLOROGALUM PURPUREUM VAR. PURPUREUM
CALIFORNIA	ENDANGERED	LILIACEAE	CHLOROGALUM PURPUREUM VAR. REDUCTUM
CALIFORNIA	ENDANGERED	LILIACEAE	ERYTHRONIUM GRANDIFLORUM SSP. PUSATERII
CALIFORNIA	ENDANGERED	LILIACEAE	FRITILLARIA PHAEANTHERA
CALIFORNIA	ENDANGERED	LILIACEAE	FRITILLARIA RODERICKII
CALIFORNIA	ENDANGERED	LILIACEAE	LILIUM OCCIDENTALE
CALIFORNIA	ENDANGERED	LILIACEAE	LILIUM PITKINENSE
CALIFORNIA	ENDANGERED	LILIACEAE	LILIUM WASHINGTONIANUM VAR. MINUS
CALIFORNIA	ENDANGERED	LILIACEAE	NOLINA INTERRATA
CALIFORNIA	ENDANGERED	LIMNANTHACEAE	LIMNANTHES BAKERI
CALIFORNIA	ENDANGERED	LIMNANTHACEAE	LIMNANTHES GRACILIS VAR. PARISHII
CALIFORNIA	ENDANGERED	LIMNANTHACEAE	LIMNANTHES VINCULANS
CALIFORNIA	ENDANGERED	LINACEAE	HESPEROLINON CONGESTUM
CALIFORNIA	ENDANGERED	LINACEAE	HESPEROLINON DIDYMOCARPUM
CALIFORNIA	ENDANGERED	LOASACEAE	MENTZELIA LEUCOPHYLLA
CALIFORNIA	ENDANGERED	MALVACEAE	HIBISCUS CALIFORNICUS
CALIFORNIA	ENDANGERED	MALVACEAE	LAVATERA ASSURGENTIFLORA
CALIFORNIA	ENDANGERED	MALVACEAE	MALACOTHAMNUS CLEMENTINUS
CALIFORNIA	ENDANGERED	MALVACEAE	MALACOTHAMNUS FASCICULATUS
CALIFORNIA	ENDANGERED	MALVACEAE	MALACOTHAMNUS PALMERI VAR. INVOLUCRATUS
CALIFORNIA	ENDANGERED	MALVACEAE	SIDALCEA COVILLEI
CALIFORNIA	ENDANGERED	NYCTAGINACEAE	ABRONIA ALPINA
CALIFORNIA	ENDANGERED	ONAGRACEAE	CAMISSONIA GUADALUPENSIS SSP. CLEMENTINA
CALIFORNIA	ENDANGERED	ONAGRACEAE	CLARKIA FRANCISCANA
CALIFORNIA	ENDANGERED	ONAGRACEAE	CLARKIA IMBRICATA
CALIFORNIA	ENDANGERED	ONAGRACEAE	CLARKIA SPECIOSA SSP. IMMACULATA
CALIFORNIA	ENDANGERED	ONAGRACEAE	EPILOBIUM NIVIUM
CALIFORNIA	ENDANGERED	ONAGRACEAE	OENOTHERA AVITA SSP. EUREKENSIS
CALIFORNIA	ENDANGERED	ONAGRACEAE	OENOTHERA DELTOIDES VAR. HOWELLII
CALIFORNIA	ENDANGERED	ORCHIDACEAE	PLATANTHERA UNALASKENSIS SSP. MARITIMA
CALIFORNIA	ENDANGERED	PAPAVERACEAE	ESCHSCHOLZIA RAMOSA
CALIFORNIA	ENDANGERED	POACEAE	AGROSTIS BLASDALEI VAR. MARINENSIS
CALIFORNIA	ENDANGERED	POACEAE	NEOSTAPFIA COLUSANA
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA CALIFORNICA VAR. VISCIDA
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA CALIFORNICA VAR. CALIFORNICA
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA CALIFORNICA VAR. INAEQUALIS
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA MUCRONATA
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA PILOSA
CALIFORNIA	ENDANGERED	POACEAE	ORCUTTIA TENUIS
CALIFORNIA	ENDANGERED	POACEAE	PLEUROPOGON HOOVERIANUS
CALIFORNIA	ENDANGERED	POACEAE	POA ATROPURPUREA
CALIFORNIA	ENDANGERED	POACEAE	POA FIBRATA
CALIFORNIA	ENDANGERED	POACEAE	POA NAPENSIS
CALIFORNIA	ENDANGERED	POACEAE	STIPA LEMMONII VAR. PUBESCENS
CALIFORNIA	ENDANGERED	POACEAE	SWALLENIA ALEXANDRAE
CALIFORNIA	ENDANGERED	POLEMONIACEAE	NAVARRETIA PAUCIFLORA
CALIFORNIA	ENDANGERED	POLEMONIACEAE	NAVARRETIA PLIEANTHA
CALIFORNIA	ENDANGERED	POLEMONIACEAE	NAVARRETIA SETILOBA
CALIFORNIA	ENDANGERED	POLEMONIACEAE	PHLOX HIRSUTA
CALIFORNIA	ENDANGERED	POLYGONACEAE	CHORIZANTHE LEPTOCERAS
CALIFORNIA	ENDANGERED	POLYGONACEAE	CHORIZANTHE ORCUTTIANA
CALIFORNIA	ENDANGERED	POLYGONACEAE	CHORIZANTHE SPINOSA
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM ALPINUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM APRICUM VAR. APRICUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM APRICUM VAR. PROSTRATUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM BREEDLOVEI
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM BUTTERWORTHIANUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM CROCATUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM ERICIFOLIUM VAR. THORNEI
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM GIGANTEUM VAR. COMPACTUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM GILMANII
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM GRANDE VAR. TIMORUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM HIRTELLUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM INTRAFRACTUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM KENNEDYI VAR. PINICOLA
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM MICROTHECUM VAR. JOHNSTONII
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM NUDUM VAR. MURINUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM PARVIFOLIUM VAR. LUCIDUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM UMBELLATUM VAR. MINUS
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM UMBELLATUM VAR. TORREYANUM
CALIFORNIA	ENDANGERED	POLYGONACEAE	ERIOGONUM WRIGHTII VAR. OLANCHENSE
CALIFORNIA	ENDANGERED	RANUNCULACEAE	DELPHINIUM BAKERI
CALIFORNIA	ENDANGERED	RANUNCULACEAE	DELPHINIUM KINKIENSE
CALIFORNIA	ENDANGERED	RANUNCULACEAE	DELPHINIUM LUTEUM
CALIFORNIA	ENDANGERED	RHAMNACEAE	CEANOTHUS FERRISAE
CALIFORNIA	ENDANGERED	RHAMNACEAE	CEANOTHUS HEARSTIORUM
CALIFORNIA	ENDANGERED	RHAMNACEAE	CEANOTHUS MARITIMUS
CALIFORNIA	ENDANGERED	RHAMNACEAE	CEANOTHUS MASONII

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	ENDANGERED	ROSACEAE	CERCOCARPUS TRASKIAE
CALIFORNIA	ENDANGERED	ROSACEAE	HORKELIA WILDERAE
CALIFORNIA	ENDANGERED	ROSACEAE	IVESIA CALLIDA
CALIFORNIA	ENDANGERED	ROSACEAE	LYONOTHAMNUS FLORIBUNDUS
CALIFORNIA	ENDANGERED	ROSACEAE	POTENTILLA HICKMANII
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM ANGUSTIFOLIUM SSP. BORREGOENSE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM CALIFORNICUM SSP. LUCIENSE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM CALIFORNICUM SSP. SIERRAE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM CALIFORNICUM SSP. PRIMUM
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM CATALINENSE SSP. ACRISPUM
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM GLABRESCENS SSP. MODOCENSE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM GRANDE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM HARDHAMAE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM HILENDIAE SSP. KINGSTONENSE
CALIFORNIA	ENDANGERED	RUBIACEAE	GALIUM SERPENTICUM SSP. SCOTTICUM
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA HOLOLEUCA SSP. GRISEA
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA ULIGINOSA
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS BERNARDINUS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS BRUNNEUS VAR. CAPILLARIS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS LITTORALIS SSP. LITTORALIS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS MARITIMUS SSP. MARITIMUS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS NIDULARIUS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	CORDYLANTHUS PALLESCENS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	GRATIOLA HETEROSEPALA
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	MIMULUS GUTTATUS SSP. ARENICOLA
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	MIMULUS PYGMAEUS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	MIMULUS WHIPPLEI
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	ORTHOCARPUS CASTILLEJOIDES VAR. HUMBOLDTIENSIS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	ORTHOCARPUS SUCCULENTIS
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	PEDICULARIS DUDLEYI
CALIFORNIA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON PERSONATUS
CALIFORNIA	ENDANGERED	STERCULIACEAE	FREMONTODENDRON DECUMBENS
CALIFORNIA	ENDANGERED	STERCULIACEAE	FREMONTODENDRON MEXICANUM
CALIFORNIA	THREATENED	APIACEAE	CYMOPTERUS DESERTICOLA
CALIFORNIA	THREATENED	APIACEAE	ERYNGIUM RACEMOSUM
CALIFORNIA	THREATENED	APIACEAE	LOMATIUM CONGDONII
CALIFORNIA	THREATENED	APIACEAE	PERIDERIDIA LEPTOCARPA
CALIFORNIA	THREATENED	APIACEAE	SANICULA SAXATILIS
CALIFORNIA	THREATENED	APIACEAE	TAUSCHIA HOWELLII
CALIFORNIA	THREATENED	ASTERACEAE	ANTENNARIA SUFFRUTESCENS
CALIFORNIA	THREATENED	ASTERACEAE	ARNICA VENOSA
CALIFORNIA	THREATENED	ASTERACEAE	ARNICA VISCOSA
CALIFORNIA	THREATENED	ASTERACEAE	ARTEMISIA CANA SSP. BOLANDERI
CALIFORNIA	THREATENED	ASTERACEAE	ASTER BRICKELLIOIDES
CALIFORNIA	THREATENED	ASTERACEAE	ASTER GREATEI
CALIFORNIA	THREATENED	ASTERACEAE	ASTER PEIRSONII
CALIFORNIA	THREATENED	ASTERACEAE	BRICKELLIA KNAPPIANA
CALIFORNIA	THREATENED	ASTERACEAE	CHAENACTIS PARISHII
CALIFORNIA	THREATENED	ASTERACEAE	CIRSIUM CAMPYLON
CALIFORNIA	THREATENED	ASTERACEAE	CIRSIUM CRASSICAULE
CALIFORNIA	THREATENED	ASTERACEAE	CIRSIUM HYDROPHILUM VAR. VASEYI
CALIFORNIA	THREATENED	ASTERACEAE	COREOPSIS HAMILTONII
CALIFORNIA	THREATENED	ASTERACEAE	ENCELIOPSIS COVILLEI
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON AEQUIFOLIUS
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON BLOOMERI VAR. NUDATUS
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON FLEXUOSUS
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON MULTICEPS
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON PARISHII
CALIFORNIA	THREATENED	ASTERACEAE	ERIGERON SUPPLEX
CALIFORNIA	THREATENED	ASTERACEAE	ERIOPHYLLUM LATILOBUM
CALIFORNIA	THREATENED	ASTERACEAE	ERIOPHYLLUM NUBIGENUM VAR. CONGDONII
CALIFORNIA	THREATENED	ASTERACEAE	GRINDELIA FRAXINO-PRATENSIS
CALIFORNIA	THREATENED	ASTERACEAE	GRINDELIA HALLII
CALIFORNIA	THREATENED	ASTERACEAE	GUTIERREZIA CALIFORNICA
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS BRICKELLIOIDES
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS CANUS
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS EXIMIUS
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS OPHITIDIS
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS RACEMOSUS SSP. CONGESTUS
CALIFORNIA	THREATENED	ASTERACEAE	HAPLOPAPPUS UNIFLORUS SSP. GOSSYPINUS
CALIFORNIA	THREATENED	ASTERACEAE	HELIANTHELLA CASTANEA
CALIFORNIA	THREATENED	ASTERACEAE	HEMIZONIA ARIDA
CALIFORNIA	THREATENED	ASTERACEAE	HEMIZONIA HALLIANA
CALIFORNIA	THREATENED	ASTERACEAE	HEMIZONIA MOHAVENSIS
CALIFORNIA	THREATENED	ASTERACEAE	HULSEA INYOENSIS
CALIFORNIA	THREATENED	ASTERACEAE	LASTHENIA CONJUGENS
CALIFORNIA	THREATENED	ASTERACEAE	LASTHENIA LEPTALEA
CALIFORNIA	THREATENED	ASTERACEAE	LASTHENIA MINOR VAR. MARITIMA
CALIFORNIA	THREATENED	ASTERACEAE	LAYIA JONESII
CALIFORNIA	THREATENED	ASTERACEAE	LAYIA LEUCOPAPPA
CALIFORNIA	THREATENED	ASTERACEAE	LAYIA ZIEGLERI
CALIFORNIA	THREATENED	ASTERACEAE	MACHAERANTHERA AMMOPHILA
CALIFORNIA	THREATENED	ASTERACEAE	MACHAERANTHERA COGNATA
CALIFORNIA	THREATENED	ASTERACEAE	MACHAERANTHERA LAGUNENSIS
CALIFORNIA	THREATENED	ASTERACEAE	MACHAERANTHERA ORCUTTII
CALIFORNIA	THREATENED	ASTERACEAE	MALACOTHRIX SAXATILIS VAR. ARACHNOIDEA
CALIFORNIA	THREATENED	ASTERACEAE	MICROSERIS HOWELLII
CALIFORNIA	THREATENED	ASTERACEAE	PENTACHAETA EXILIS SSP. AEOLICA
CALIFORNIA	THREATENED	ASTERACEAE	PERITYLE INYOENSIS
CALIFORNIA	THREATENED	ASTERACEAE	PERITYLE VILLOSA
CALIFORNIA	THREATENED	ASTERACEAE	PSEUDOBAHIA BAHIAEFOLIA
CALIFORNIA	THREATENED	ASTERACEAE	RAILLARDELLA MUIRII
CALIFORNIA	THREATENED	ASTERACEAE	RAILLARDELLA PRINGLEI
CALIFORNIA	THREATENED	ASTERACEAE	SENECIO BERNARDINUS

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	THREATENED	ASTERACEAE	SENECIO GANDERI
CALIFORNIA	THREATENED	ASTERACEAE	SENECIO HESPERIUS
CALIFORNIA	THREATENED	ASTERACEAE	TANACETUM CAMPHORATUM
CALIFORNIA	THREATENED	ASTERACEAE	TARAXACUM CALIFORNICUM
CALIFORNIA	THREATENED	ASTERACEAE	WYETHIA RETICULATA
CALIFORNIA	THREATENED	BERBERIDACEAE	BERBERIS PINNATA SSP. INSULARIS
CALIFORNIA	THREATENED	BERBERIDACEAE	VANCOUVERIA CHRYSANTHA
CALIFORNIA	THREATENED	BORAGINACEAE	AMSINCKIA VERNICOSA VAR. FURCATA
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA CRINITA
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA CRYMOPHILA
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA GANDERI
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA HOFFMANNII
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA TRASKIAE
CALIFORNIA	THREATENED	BORAGINACEAE	CRYPTANTHA TUMULOSA
CALIFORNIA	THREATENED	BORAGINACEAE	HACKELIA SHARSMITHII
CALIFORNIA	THREATENED	BORAGINACEAE	PLAGIOBOTHRYS DISTANTIFLORUS
CALIFORNIA	THREATENED	BORAGINACEAE	PLAGIOBOTHRYS GLABER
CALIFORNIA	THREATENED	BORAGINACEAE	PLAGIOBOTHRYS HYSTRICULUS
CALIFORNIA	THREATENED	BORAGINACEAE	PLAGIOBOTHRYS SCRIPTUS
CALIFORNIA	THREATENED	BORAGINACEAE	PLAGIOBOTHRYS STRICTUS
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS BLEPHAROPHYLLA
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS BREWERI VAR. AUSTINAE
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS CONSTANCEI
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS HOFFMANNII
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS JOHNSTONII
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS OREGANA
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS PARISHII
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS PYGMAEA
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS SHOCKLEYI
CALIFORNIA	THREATENED	BRASSICACEAE	ARABIS SUFFRUTESCENS VAR. PERSTYLOSA
CALIFORNIA	THREATENED	BRASSICACEAE	CAULANTHUS AMPLEXICAULIS VAR. BARBARAE
CALIFORNIA	THREATENED	BRASSICACEAE	CAULOSTRAMINA JAEGERI
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA ASTEROPHORA VAR. ASTEROPHORA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA ASTEROPHORA VAR. MACROCARPA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA CRUCIATA VAR. CRUCIATA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA CRUCIATA VAR. INTEGRIFOLIA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA DOUGLASII
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA HOWELLII VAR. CARNOSULA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA LEMMONII VAR. INCRASSATA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA QUADRICOSTATA
CALIFORNIA	THREATENED	BRASSICACEAE	DRABA STENOLOBA VAR. RAMOSA
CALIFORNIA	THREATENED	BRASSICACEAE	ERYSIMUM AMMOPHILUM
CALIFORNIA	THREATENED	BRASSICACEAE	ERYSIMUM INSULARE
CALIFORNIA	THREATENED	BRASSICACEAE	ERYSIMUM MENZIESII
CALIFORNIA	THREATENED	BRASSICACEAE	ERYSIMUM TERETIFOLIUM
CALIFORNIA	THREATENED	BRASSICACEAE	HALIMOLOBOS VIRGATA
CALIFORNIA	THREATENED	BRASSICACEAE	LESQUERELLA KINGII SSP. BERNARDINA
CALIFORNIA	THREATENED	BRASSICACEAE	RORIPPA COLUMBIAE
CALIFORNIA	THREATENED	BRASSICACEAE	RORIPPA SUBUMBELLATA
CALIFORNIA	THREATENED	BRASSICACEAE	SIBARA FILIFOLIA
CALIFORNIA	THREATENED	BRASSICACEAE	SIBARA ROSULATA
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS BATRACHOPUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS BRACHIATUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS CORDATUS VAR. PIUTENSIS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS FENESTRATUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS GLANDULOSUS VAR. PULCHELLUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS GRACILIS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS HISPIDUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS MORRISONII SSP. ELATUS
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS MORRISONII SSP. MORRISONII
CALIFORNIA	THREATENED	BRASSICACEAE	STREPTANTHUS OLIGANTHUS
CALIFORNIA	THREATENED	BRASSICACEAE	THELYPODIUM BRACHYCARPUM
CALIFORNIA	THREATENED	BRASSICACEAE	THELYPODIUM STENOPETALUM
CALIFORNIA	THREATENED	BRASSICACEAE	THYSANOCARPUS CONCHULIFERUS
CALIFORNIA	THREATENED	BRASSICACEAE	TROPIDOCARPUM CAPPARIDEUM
CALIFORNIA	THREATENED	CACTACEAE	CORYPHANTHA VIVIPARA VAR. ALVERSONII
CALIFORNIA	THREATENED	CACTACEAE	CORYPHANTHA VIVIPARA VAR. ROSEA
CALIFORNIA	THREATENED	CACTACEAE	ECHINOCEREUS ENGELMANNII VAR. MUNZII
CALIFORNIA	THREATENED	CACTACEAE	OPUNTIA BASILARIS VAR. BRACHYCLADA
CALIFORNIA	THREATENED	CACTACEAE	OPUNTIA MUNZII
CALIFORNIA	THREATENED	CACTACEAE	OPUNTIA PARRYI VAR. SERPENTINA
CALIFORNIA	THREATENED	CACTACEAE	OPUNTIA PHAEACANTHA VAR. MOJAVENSIS
CALIFORNIA	THREATENED	CAMPANULACEAE	CAMPANULA SHETLERI
CALIFORNIA	THREATENED	CAMPANULACEAE	CAMPANULA WILKINSIANA
CALIFORNIA	THREATENED	CAMPANULACEAE	NEMACLADUS TWISSELMANNII
CALIFORNIA	THREATENED	CARYOPHYLLACEAE	ARENARIA PALUDICOLA
CALIFORNIA	THREATENED	CARYOPHYLLACEAE	ARENARIA ROSEI
CALIFORNIA	THREATENED	CARYOPHYLLACEAE	SILENE INVISA
CALIFORNIA	THREATENED	CHENOPODIACEAE	ATRIPLEX VALLICOLA
CALIFORNIA	THREATENED	CISTACEAE	HELIANTHEMUM SUFFRUTESCENS
CALIFORNIA	THREATENED	CONVOLVULACEAE	CALYSTEGIA PEIRSONII
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA BLOCHMANAE SSP. BREVIFOLIA
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA BLOCHMANAE SSP. INSULARIS
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA DENSIFLORA
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA PARVA
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA VARIEGATA
CALIFORNIA	THREATENED	CRASSULACEAE	DUDLEYA VISCIDA
CALIFORNIA	THREATENED	CRASSULACEAE	SEDUM LAXUM SSP. HECKNERI
CALIFORNIA	THREATENED	CRASSULACEAE	SEDUM NIVEUM
CALIFORNIA	THREATENED	CROSSOSOMATACEAE	CROSSOSOMA CALIFORNICUM
CALIFORNIA	THREATENED	CUPRESSACEAE	CUPRESSUS ARIZONICA VAR. STEPHENSONII
CALIFORNIA	THREATENED	CUPRESSACEAE	CUPRESSUS ARIZONICA VAR. NEVADENSIS
CALIFORNIA	THREATENED	CUPRESSACEAE	CUPRESSUS MACROCARPA

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	THREATENED	CYPERACEAE	CAREX OBISPOENSIS
CALIFORNIA	THREATENED	CYPERACEAE	CAREX PAUCIFRUCTA
CALIFORNIA	THREATENED	CYPERACEAE	CAREX WHITNEYI
CALIFORNIA	THREATENED	EPHEDRACEAE	EPHEDRA FUNEREA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS CRUZENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS EDMUNDSII
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS INTRICATA VAR. OBLONGIFOLIA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS LUCIANA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS MONTANA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS MONTARAENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS MONTEREYENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS MORROENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS NISSENANA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS OTAYENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS PECHOENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS REFUGIOENSIS
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS SILVICOLA
CALIFORNIA	THREATENED	ERICACEAE	ARCTOSTAPHYLOS VIRGATA
CALIFORNIA	THREATENED	ERICACEAE	PITYOPUS CALIFORNICUS
CALIFORNIA	THREATENED	ERICACEAE	VACCINIUM COCCINIUM
CALIFORNIA	THREATENED	EUPHORBIACEAE	DITAXIS CALIFORNICA
CALIFORNIA	THREATENED	EUPHORBIACEAE	EUPHORBIA HOOVERI
CALIFORNIA	THREATENED	EUPHORBIACEAE	EUPHORBIA OCELLATA VAR. RATTANII
CALIFORNIA	THREATENED	EUPHORBIACEAE	TETRACOCCUS ILICIFOLIUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS AGNICIDUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS BRAUNTONII
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS CIMAE VAR. SUFFLATUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS DEANEI
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS FUNEREUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS LENTIFORMIS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS LENTIGINOSUS VAR. MICANS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS MOHAVENSIS VAR. HEMIGYRUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS PANAMINTENSIS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS PSEUDIODANTHUS
CALIFORNIA	THREATENED	FABACEAE	ASTRAGALUS SUBVESTITUS
CALIFORNIA	THREATENED	FABACEAE	DALEA ARBORESCENS
CALIFORNIA	THREATENED	FABACEAE	LOTUS ARGOPHYLLUS VAR. NIVEUS
CALIFORNIA	THREATENED	FABACEAE	LOTUS NUTTALIANUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS CERVINUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS CITRINUS VAR. CITRINUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS CITRINUS VAR. DEFLEXUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS DEDECKERAE
CALIFORNIA	THREATENED	FABACEAE	LUPINUS HOLMGRENANUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS INYOENSIS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS MONTIGENUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS PEIRSONII
CALIFORNIA	THREATENED	FABACEAE	LUPINUS SERICATUS
CALIFORNIA	THREATENED	FABACEAE	LUPINUS SPECTABILIS
CALIFORNIA	THREATENED	FABACEAE	THERMOPSIS MACROPHYLLA VAR. AGNINA
CALIFORNIA	THREATENED	FABACEAE	TRIFOLIUM BOLANDERI
CALIFORNIA	THREATENED	FABACEAE	TRIFOLIUM DEDECKERAE
CALIFORNIA	THREATENED	FAGACEAE	QUERCUS PARVULA
CALIFORNIA	THREATENED	FAGACEAE	QUERCUS TOMENTELLA
CALIFORNIA	THREATENED	FUMARIACEAE	DICENTRA FORMOSA SSP. NEVADENSIS
CALIFORNIA	THREATENED	GENTIANACEAE	FRASERA PUBERULENTA
CALIFORNIA	THREATENED	GENTIANACEAE	FRASERA TUBULOSA
CALIFORNIA	THREATENED	GENTIANACEAE	FRASERA UMPQUAENSIS
CALIFORNIA	THREATENED	GENTIANACEAE	GENTIANA FREMONTII
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA AMABILIS
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA ANELSONII
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA DALESIANA
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA DIVARICATA VAR. INSULARIS
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA GREENEI
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA MUSTELINA
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA NOVENMILLENSIS
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA OROGENES
CALIFORNIA	THREATENED	HYDROPHYLLACEAE	PHACELIA PHACELIOIDES
CALIFORNIA	THREATENED	ISOETACEAE	ISOETES BOLANDERI VAR. PYGMAEA
CALIFORNIA	THREATENED	ISOETACEAE	ISOETES ORCUTTII
CALIFORNIA	THREATENED	JUNCACEAE	JUNCUS LEIOSPERMUS
CALIFORNIA	THREATENED	LAMIACEAE	AGASTACHE PARVIFOLIA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA ANTONINA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA BENITENSIS
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA CRISPA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA HYPOLEUCA SSP. LANATA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA LINOIDES SSP. OBLONGA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA PALMERI
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA PURPUREA
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA ROBISONII
CALIFORNIA	THREATENED	LAMIACEAE	MONARDELLA VIRIDIS SSP. SAXICOLA
CALIFORNIA	THREATENED	LAMIACEAE	POGOGYNE NUDIUSCULA
CALIFORNIA	THREATENED	LAMIACEAE	SALVIA EREMOSTACHYA
CALIFORNIA	THREATENED	LAMIACEAE	SALVIA FUNEREA
CALIFORNIA	THREATENED	LAMIACEAE	SATUREJA CHANDLERI
CALIFORNIA	THREATENED	LILIACEAE	AGAVE UTAHENSIS VAR. NEVADENSIS
CALIFORNIA	THREATENED	LILIACEAE	ALLIUM HOFFMANII
CALIFORNIA	THREATENED	LILIACEAE	ALLIUM YOSEMITENSE
CALIFORNIA	THREATENED	LILIACEAE	BRODIAEA KINKIENSIS
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS DUNNEI
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS GREENEI
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS OBISPOENSIS
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS PERSISTENS
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS SIMULANS
CALIFORNIA	THREATENED	LILIACEAE	CALOCHORTUS STRIATUS

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	THREATENED	LILIACEAE	ERYTHRONIUM HELENAE
CALIFORNIA	THREATENED	LILIACEAE	ERYTHRONIUM HOWELLII
CALIFORNIA	THREATENED	LILIACEAE	ERYTHRONIUM TUOLUMNENSE
CALIFORNIA	THREATENED	LILIACEAE	FRITILLARIA BRANDEGEI
CALIFORNIA	THREATENED	LILIACEAE	FRITILLARIA FALCATA
CALIFORNIA	THREATENED	LILIACEAE	FRITILLARIA PLURIFLORA
CALIFORNIA	THREATENED	LILIACEAE	FRITILLARIA STRIATA
CALIFORNIA	THREATENED	LILIACEAE	LILIUM VOLLMERI
CALIFORNIA	THREATENED	LILIACEAE	LILIUM WIGGINSII
CALIFORNIA	THREATENED	LILIACEAE	MUILLA CLEVELANDII
CALIFORNIA	THREATENED	LILIACEAE	SCHOENOLIRION BRACTEOSUM
CALIFORNIA	THREATENED	LILIACEAE	TRITELEIA CLEMENTINA
CALIFORNIA	THREATENED	LILIACEAE	TRITELEIA DUDLEYI
CALIFORNIA	THREATENED	LILIACEAE	VERATRUM FIMBRIATUM
CALIFORNIA	THREATENED	LIMNANTHACEAE	LIMNANTHES DOUGLASII VAR. SULPHUREA
CALIFORNIA	THREATENED	LIMNANTHACEAE	LIMNANTHES FLOCCOSA SSP. BELLINGERIANA
CALIFORNIA	THREATENED	LINACEAE	HESPEROLINON ADENOPHYLLUM
CALIFORNIA	THREATENED	LINACEAE	HESPEROLINON BICARPELLATUM
CALIFORNIA	THREATENED	LINACEAE	HESPEROLINON BREWERI
CALIFORNIA	THREATENED	LINACEAE	HESPEROLINON DRYMARIOIDES
CALIFORNIA	THREATENED	LOASACEAE	MENTZELIA HIRSUTISSIMA VAR. STENOPHYLLA
CALIFORNIA	THREATENED	LOASACEAE	PETALONYX THURBERI SSP. GILMANII
CALIFORNIA	THREATENED	MALVACEAE	MALACOTHAMNUS PALMERI VAR. LUCIANUS
CALIFORNIA	THREATENED	MALVACEAE	MALACOTHAMNUS PALMERI VAR. PALMERI
CALIFORNIA	THREATENED	MALVACEAE	MALACOTHAMNUS PARISHII
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA HICKMANII SSP. ANOMALA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA HICKMANII SSP. HICKMANII
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA HICKMANII SSP. VIRIDIS
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA HICKMANII SSP. PARISHII
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA KECKII
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA MALVAEFLORA SSP. ELEGANS
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA OREGANA SSP. HYDROPHILA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA OREGANA SSP. VALIDA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA PEDATA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA ROBUSTA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA SETOSA
CALIFORNIA	THREATENED	MALVACEAE	SIDALCEA STIPULARIS
CALIFORNIA	THREATENED	MALVACEAE	SPHAERALCEA RUSBYI SSP. EREMICOLA
CALIFORNIA	THREATENED	ONAGRACEAE	CAMISSONIA BENITENSIS
CALIFORNIA	THREATENED	ONAGRACEAE	CAMISSONIA TANACETIFOLIA SSP. QUADRIPERFORATA
CALIFORNIA	THREATENED	ONAGRACEAE	CLARKIA AMOENA SSP. WHITNEYI
CALIFORNIA	THREATENED	ONAGRACEAE	CLARKIA BILOBA SSP. AUSTRALIS
CALIFORNIA	THREATENED	ONAGRACEAE	CLARKIA LINGULATA
CALIFORNIA	THREATENED	ONAGRACEAE	CLARKIA ROSTRATA
CALIFORNIA	THREATENED	OPHIOGLOSSACEAE	OPHIOGLOSSUM LUSITANICUM VAR. CALIFORNICUM
CALIFORNIA	THREATENED	ORCHIDACEAE	CYPRIPEDIUM CALIFORNICUM
CALIFORNIA	THREATENED	OROBANCHACEAE	OROBANCHE PARISHII SSP. BRACHYLOBA
CALIFORNIA	THREATENED	PAPAVERACEAE	ARCTOMECON MERRIAMII
CALIFORNIA	THREATENED	PAPAVERACEAE	ARGEMONE MUNITA SSP. ROBUSTA
CALIFORNIA	THREATENED	PAPAVERACEAE	ESCHSCHOLZIA PROCERA
CALIFORNIA	THREATENED	POACEAE	AGROSTIS ARISTIGLUMIS
CALIFORNIA	THREATENED	POACEAE	AGROSTIS CLIVICOLA VAR. PUNTA-REYESENSIS
CALIFORNIA	THREATENED	POACEAE	CALAMAGROSTIS CRASSIGLUMIS
CALIFORNIA	THREATENED	POACEAE	CALAMAGROSTIS FOLIOSA
CALIFORNIA	THREATENED	POACEAE	PUCCINELLIA PARISHII
CALIFORNIA	THREATENED	POLEMONIACEAE	COLLOMIA RAWSONIANA
CALIFORNIA	THREATENED	POLEMONIACEAE	ERIASTRUM BRANDEGEAE
CALIFORNIA	THREATENED	POLEMONIACEAE	ERIASTRUM TRACYI
CALIFORNIA	THREATENED	POLEMONIACEAE	GILIA RIPLEYI
CALIFORNIA	THREATENED	POLEMONIACEAE	GILIA TENUIFLORA SSP. HOFFMANNII
CALIFORNIA	THREATENED	POLEMONIACEAE	LEPTODACTYLON JAEGERI
CALIFORNIA	THREATENED	POLEMONIACEAE	LINANTHUS ARENICOLA
CALIFORNIA	THREATENED	POLEMONIACEAE	LINANTHUS MACULATUS
CALIFORNIA	THREATENED	POLEMONIACEAE	LINANTHUS ORCUTTII SSP. PACIFICUS
CALIFORNIA	THREATENED	POLEMONIACEAE	NAVARRETIA PROLIFERA SSP. LUTEA
CALIFORNIA	THREATENED	POLEMONIACEAE	PHLOX DOLICANTHA
CALIFORNIA	THREATENED	POLEMONIACEAE	POLEMONIUM CHARTACEUM
CALIFORNIA	THREATENED	POLYGONACEAE	CHORIZANTHE BLAKLEYI
CALIFORNIA	THREATENED	POLYGONACEAE	CHORIZANTHE BREWERI
CALIFORNIA	THREATENED	POLYGONACEAE	CHORIZANTHE HOWELLII
CALIFORNIA	THREATENED	POLYGONACEAE	CHORIZANTHE PARRYI VAR. FERNANDINA
CALIFORNIA	THREATENED	POLYGONACEAE	CHORIZANTHE STATICOIDES SSP. CHRYSACANTHA
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM AMPULLACEUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM BIFURCATUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM CONGDONII
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM DESERTICOLA
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM EASTWOODIANUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM EREMICOLA
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM GOSSYPINUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM HOFFMANNII VAR. HOFFMANNII
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM HOFFMANNII VAR. ROBUSTIUS
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM KELLOGGII
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM LATENS
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM MICROTHECUM VAR. PANAMINTENSE
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM OVALIFOLIUM VAR. VINEUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM PARVIFOLIUM VAR. PAYNEI
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM SISKIYOUENSE
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM TEMBLORENSE
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM TRUNCATUM
CALIFORNIA	THREATENED	POLYGONACEAE	ERIOGONUM TWISSELMANNII
CALIFORNIA	THREATENED	POLYGONACEAE	GILMANIA LUTEOLA
CALIFORNIA	THREATENED	POLYGONACEAE	POLYGONUM MARINENSE
CALIFORNIA	THREATENED	POLYPODIACEAE	CHEILANTHES FIBRILLOSA
CALIFORNIA	THREATENED	PORTULACACEAE	CLAYTONIA BELLIDIFOLIA

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
CALIFORNIA	THREATENED	PORTULACACEAE	CLAYTONIA LANCEOLATA VAR. PEIRSONII
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA CANTELOWII
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA CONGDONII
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA COTYLEDON
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA DISEPALA
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA OPPOSITIFOLIA
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA PYGMAEA SSP. LONGIPETALA
CALIFORNIA	THREATENED	PORTULACACEAE	LEWISIA SERRATA
CALIFORNIA	THREATENED	RANUNCULACEAE	DELPHINIUM HESPERIUM SSP. CUYAMACAE
CALIFORNIA	THREATENED	RANUNCULACEAE	DELPHINIUM HUTCHINSONAE
CALIFORNIA	THREATENED	RANUNCULACEAE	DELPHINIUM INOPINUM
CALIFORNIA	THREATENED	RANUNCULACEAE	DELPHINIUM PARISHII SSP. PURPUREUM
CALIFORNIA	THREATENED	RANUNCULACEAE	DELPHINIUM VARIEGATUM SSP. THORNEI
CALIFORNIA	THREATENED	RHAMNACEAE	CEANOTHUS ARBOREUS
CALIFORNIA	THREATENED	RHAMNACEAE	CEANOTHUS CYANEUS
CALIFORNIA	THREATENED	RHAMNACEAE	CEANOTHUS GLORIOSUS VAR. PORRECTUS
CALIFORNIA	THREATENED	RHAMNACEAE	CEANOTHUS RIGIDUS
CALIFORNIA	THREATENED	RHAMNACEAE	CEANOTHUS RODERICKII
CALIFORNIA	THREATENED	ROSACEAE	HORKELIA TULARENSIS
CALIFORNIA	THREATENED	ROSACEAE	IVESIA ARGYROCOMA
CALIFORNIA	THREATENED	ROSACEAE	IVESIA PICKERINGII
CALIFORNIA	THREATENED	ROSACEAE	POTENTILLA PATELLIFERA
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM ANDREWSII VAR. GATENSE
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM BUXIFOLIUM
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM CALIFORNICUM VAR. MIGUELENSE
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM CLEMENTIS
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM HYPOTRICHIUM VAR. TOMENTELLUM
CALIFORNIA	THREATENED	RUBIACEAE	GALIUM SERPENTICUM SSP. WARNERENSE
CALIFORNIA	THREATENED	SARRACENIACEAE	DARLINGTONIA CALIFORNICA
CALIFORNIA	THREATENED	SAXIFRAGACEAE	CARPENTERIA CALIFORNICA
CALIFORNIA	THREATENED	SAXIFRAGACEAE	HEUCHERA BREVISTAMINEA
CALIFORNIA	THREATENED	SAXIFRAGACEAE	RIBES CANTHARIFORME
CALIFORNIA	THREATENED	SCROPHULARIACEAE	ANTIRRHINUM SUBCORDATUM
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA BREVILOBATA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA CINEREA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA GLEASONII
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA LASSENENSIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA LATIFOLIA SSP. MENDOCINENSIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA MARTINII VAR. EWANII
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA MINIATA SSP. ELATA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA MOLLIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CASTILLEJA NEGLECTA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	COLLINSIA ANTONINA SSP. ANTONINA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	COLLINSIA ANTONINA SSP. PURPUREA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS EREMICUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS MARITIMUS SSP. PALUSTRIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS MOLLIS SSP. HISPIDUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS RAMOSUS SSP. EREMICUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS TECOPENSIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	DIPLACUS ARIDIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	MAURANDYA PETROPHILA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	MIMULUS EXIGUUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	MIMULUS PICTUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	MIMULUS PURPUREUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	MIMULUS RUPICOLA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	ORTHOCARPUS FLORIBUNDUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	ORTHOCARPUS LASIORHYNCHUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PEDICULARIS HOWELLII
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON CALCAREUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON CALIFORNICUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON CINICOLA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON FILIFORMIS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON PAPILLATUS
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON STEPHENSII
CALIFORNIA	THREATENED	SCROPHULARIACEAE	PENSTEMON TRACYI
CALIFORNIA	THREATENED	SCROPHULARIACEAE	SCROPHULARIA ATRATA
CALIFORNIA	THREATENED	SCROPHULARIACEAE	VERONICA COPELANDII
CALIFORNIA	THREATENED	SOLANACEAE	SOLANUM TENUILOBATUM
CALIFORNIA	THREATENED	VIOLACEAE	VIOLA LANCEOLATA SSP. OCCIDENTALIS
CALIFORNIA	THREATENED	VIOLACEAE	VIOLA TOMENTOSA
NEVADA	ENDANGERED	APIACEAE	CYMOPTERUS NIVALIS
NEVADA	ENDANGERED	ASCLEPIADACEAE	ASCLEPIAS EASTWOODIANA
NEVADA	ENDANGERED	ASTERACEAE	CIRSIUM CLOKEYI
NEVADA	ENDANGERED	ASTERACEAE	MACHAERANTHERA LEUCANTHEMIFOLIA
NEVADA	ENDANGERED	ASTERACEAE	TANACETUM COMPACTUM
NEVADA	ENDANGERED	BRASSICACEAE	DRABA ARIDA
NEVADA	ENDANGERED	BRASSICACEAE	DRABA PAUCIFRUCTA
NEVADA	ENDANGERED	EUPHORBIACEAE	CROTON WIGGINSII
NEVADA	ENDANGERED	EUPHORBIACEAE	DITAXIS DIVERSIFLORA
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS BEATLEYAE
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS CALYCOSUS VAR. MONOPHYLLIDIUS
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS NYENSIS
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS PHOENIX
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS PORRECTUS
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS ROBBINSII VAR. OCCIDENTALIS
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS SERENOI VAR. SORDESCENS
NEVADA	ENDANGERED	FABACEAE	ASTRAGALUS UNCIALIS
NEVADA	ENDANGERED	FABACEAE	LATHYRUS HITCHCOCKIANUS
NEVADA	ENDANGERED	FABACEAE	TRIFOLIUM ANDERSONII SSP. BEATLEYAE
NEVADA	ENDANGERED	FABACEAE	TRIFOLIUM LEMMONII
NEVADA	ENDANGERED	GENTIANACEAE	CENTAURIUM NAMOPHILUM
NEVADA	ENDANGERED	GENTIANACEAE	FRASERA GYPSICOLA
NEVADA	ENDANGERED	GENTIANACEAE	FRASERA PAHUTENSIS

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
NEVADA	ENDANGERED	GERANIACEAE	GERANIUM TOQUIMENSE
NEVADA	ENDANGERED	HYDROPHYLLACEAE	PHACELIA BEATLEYAE
NEVADA	ENDANGERED	LOASACEAE	MENTZELIA LEUCOPHYLLA
NEVADA	ENDANGERED	NYCTAGINACEAE	MIRABILIS PUDICA
NEVADA	ENDANGERED	ONAGRACEAE	CAMISSONIA MEGALANTHA
NEVADA	ENDANGERED	ONAGRACEAE	CAMISSONIA NEVADENSIS
NEVADA	ENDANGERED	POLYGONACEAE	ERIOGONUM ANEMOPHILUM
NEVADA	ENDANGERED	POLYGONACEAE	ERIOGONUM ARGOPHYLLUM
NEVADA	ENDANGERED	PRIMULACEAE	PRIMULA CAPILLARIS
NEVADA	ENDANGERED	PRIMULACEAE	PRIMULA NEVADENSIS
NEVADA	ENDANGERED	ROSACEAE	IVESIA CRYPTOCAULIS
NEVADA	ENDANGERED	ROSACEAE	IVESIA EREMICA
NEVADA	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA SALSUGINOSA
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON DECURVUS
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON KECKII
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON NANUS
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON NYEENSIS
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON PAHUTENSIS
NEVADA	ENDANGERED	SCROPHULARIACEAE	PENSTEMON RUBICUNDUS
NEVADA	ENDANGERED	SCROPHULARIACEAE	SYNTHYRIS RANUNCULINA
NEVADA	THREATENED	APIACEAE	ANGELICA SCABRIDA
NEVADA	THREATENED	APIACEAE	CYMOPTERUS BASALTICUS
NEVADA	THREATENED	ASTERACEAE	ANTENNARIA SOLICEPS
NEVADA	THREATENED	ASTERACEAE	ENCELIOPSIS NUDICAULIS VAR. CORRUGATA
NEVADA	THREATENED	ASTERACEAE	ERIGERON OVINUS
NEVADA	THREATENED	ASTERACEAE	ERIGERON UNCIALIS VAR. CONJUGANS
NEVADA	THREATENED	ASTERACEAE	GRINDELIA FRAXINO-PRATENSIS
NEVADA	THREATENED	ASTERACEAE	HAPLOPAPPUS BRICKELLIOIDES
NEVADA	THREATENED	ASTERACEAE	HAPLOPAPPUS CANUS
NEVADA	THREATENED	ASTERACEAE	HAPLOPAPPUS EXIMIUS
NEVADA	THREATENED	ASTERACEAE	MACHAERANTHERA AMMOPHILA
NEVADA	THREATENED	ASTERACEAE	MACHAERANTHERA GRINDELIOIDES VAR. DEPRESSA
NEVADA	THREATENED	ASTERACEAE	PERITYLE MEGALOCEPHALA VAR. INTRICATA
NEVADA	THREATENED	ASTERACEAE	SENECIO LYNCEUS VAR. LEUCOREUS
NEVADA	THREATENED	ASTERACEAE	TOWNSENDIA JONESII VAR. TUMULOSA
NEVADA	THREATENED	BORAGINACEAE	CRYPTANTHA COMPACTA
NEVADA	THREATENED	BORAGINACEAE	CRYPTANTHA HOFFMANNII
NEVADA	THREATENED	BORAGINACEAE	CRYPTANTHA INTERRUPTA
NEVADA	THREATENED	BORAGINACEAE	CRYPTANTHA TUMULOSA
NEVADA	THREATENED	BRASSICACEAE	ARABIS SHOCKLEYI
NEVADA	THREATENED	BRASSICACEAE	DRABA ASTEROPHORA VAR. ASTEROPHORA
NEVADA	THREATENED	BRASSICACEAE	DRABA CRASSIFOLIA VAR. NEVADENSIS
NEVADA	THREATENED	BRASSICACEAE	DRABA DOUGLASII
NEVADA	THREATENED	BRASSICACEAE	DRABA JAEGERI
NEVADA	THREATENED	BRASSICACEAE	DRABA STENOLOBA VAR. RAMOSA
NEVADA	THREATENED	BRASSICACEAE	LEPIDIUM NANUM
NEVADA	THREATENED	BRASSICACEAE	LESQUERELLA HITCHCOCKII
NEVADA	THREATENED	BRASSICACEAE	RORIPPA SUBUMBELLATA
NEVADA	THREATENED	CACTACEAE	CORYPHANTHA VIVIPARA VAR. ROSEA
NEVADA	THREATENED	CACTACEAE	OPUNTIA WHIPPLEI VAR. MULTIGENICULATA
NEVADA	THREATENED	CACTACEAE	SCLEROCACTUS PUBISPINUS
NEVADA	THREATENED	CARYOPHYLLACEAE	ARENARIA KINGII VAR. ROSEA
NEVADA	THREATENED	CARYOPHYLLACEAE	ARENARIA STENOMERES
NEVADA	THREATENED	CARYOPHYLLACEAE	SILENE CLOKEYI
NEVADA	THREATENED	CARYOPHYLLACEAE	SILENE SCAPOSA VAR. LOBATA
NEVADA	THREATENED	EPHEDRACEAE	EPHEDRA FUNEREA
NEVADA	THREATENED	FABACEAE	ASTRAGALUS AEQUALIS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS ALVORDENSIS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS CALLITHRIX
NEVADA	THREATENED	FABACEAE	ASTRAGALUS CONVALLARIUS VAR. FINITIMUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS FUNEREUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS GEYERI VAR. TRIQUETRUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS LENTIGINOSUS VAR. LATUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS MUSIMONUM
NEVADA	THREATENED	FABACEAE	ASTRAGALUS OOPHORUS VAR. CLOKEYANUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS OOPHORUS VAR. LONCHOCALYX
NEVADA	THREATENED	FABACEAE	ASTRAGALUS PSEUDIODANTHUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS PTEROCARPUS
NEVADA	THREATENED	FABACEAE	ASTRAGALUS TOQUIMANUS
NEVADA	THREATENED	FABACEAE	DALEA KINGII
NEVADA	THREATENED	FABACEAE	LUPINUS HOLMGRENANUS
NEVADA	THREATENED	FABACEAE	LUPINUS MONTIGENUS
NEVADA	THREATENED	HYDROPHYLLACEAE	PHACELIA ANELSONII
NEVADA	THREATENED	HYDROPHYLLACEAE	PHACELIA GLABERRIMA
NEVADA	THREATENED	HYDROPHYLLACEAE	PHACELIA MUSTELINA
NEVADA	THREATENED	ISOETACEAE	ISOETES BOLANDERI VAR. PYGMAEA
NEVADA	THREATENED	LILIACEAE	AGAVE UTAHENSIS VAR. NEVADENSIS
NEVADA	THREATENED	LILIACEAE	AGAVE UTAHENSIS VAR. EBORISPINA
NEVADA	THREATENED	LILIACEAE	CALOCHORTUS STRIATUS
NEVADA	THREATENED	NYCTAGINACEAE	ABRONIA ORBICULATA
NEVADA	THREATENED	OLEACEAE	FRAXINUS CUSPIDATA VAR. MACROPETALA
NEVADA	THREATENED	ONAGRACEAE	EPILOBIUM NEVADENSE
NEVADA	THREATENED	PAPAVERACEAE	ARCTOMECON MERRIAMII
NEVADA	THREATENED	POLEMONIACEAE	GILIA NYENSIS
NEVADA	THREATENED	POLEMONIACEAE	GILIA RIPLEYI
NEVADA	THREATENED	POLEMONIACEAE	LINANTHUS ARENICOLA
NEVADA	THREATENED	POLEMONIACEAE	PHLOX GLADIFORMIS
NEVADA	THREATENED	POLEMONIACEAE	POLEMONIUM NEVADENSE
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM BIFURCATUM
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM CONCINNUM
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM EREMICUM
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM HOLMGRENII
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM OVALIFOLIUM VAR. CALLESTRINUM
NEVADA	THREATENED	POLYGONACEAE	ERIOGONUM RUBRICAULE

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
NEVADA	THREATENED	PORTULACACEAE	LEWISIA MAGUIREI
NEVADA	THREATENED	SCROPHULARIACEAE	CASTILLEJA LINOIDES
NEVADA	THREATENED	SCROPHULARIACEAE	CORDYLANTHUS TECOPENSIS
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON ARENARIUS
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON BICOLOR SSP. BICOLOR
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON BICOLOR SSP. ROSEUS
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON MODESTUS
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON PUDICUS
NEVADA	THREATENED	SCROPHULARIACEAE	PENSTEMON THOMPSONIAE SSP. JAEGERI
NEVADA	THREATENED	VIOLACEAE	VIOLA CHARLESTONENSIS
UTAH	ENDANGERED	APIACEAE	CYMOPTERUS DUCHESNENSIS
UTAH	ENDANGERED	APIACEAE	CYMOPTERUS MINIMUS
UTAH	ENDANGERED	APOCYNACEAE	CYCLADENIA JONESII
UTAH	ENDANGERED	ASTERACEAE	ERIGERON FLAGELLARIS VAR. TRILOBATUS
UTAH	ENDANGERED	ASTERACEAE	ERIGERON KACHINENSIS
UTAH	ENDANGERED	ASTERACEAE	ERIGERON MAGUIREI
UTAH	ENDANGERED	ASTERACEAE	ERIGERON RELIGIOSUS
UTAH	ENDANGERED	ASTERACEAE	ERIGERON SIONIS
UTAH	ENDANGERED	ASTERACEAE	TOWNSENDIA APRICA
UTAH	ENDANGERED	ASTERACEAE	VIGUIERA SOLICEPS
UTAH	ENDANGERED	BORAGINACEAE	CRYPTANTHA BREVIFLORA
UTAH	ENDANGERED	BORAGINACEAE	CRYPTANTHA GRAHAMII
UTAH	ENDANGERED	BORAGINACEAE	CRYPTANTHA JOHNSTONII
UTAH	ENDANGERED	BORAGINACEAE	CRYPTANTHA JONESIANA
UTAH	ENDANGERED	BORAGINACEAE	CRYPTANTHA OCHROLEUCA
UTAH	ENDANGERED	BRASSICACEAE	GLAUCOCARPUM SUFFRUTESCENS
UTAH	ENDANGERED	BRASSICACEAE	LEPIDIUM BARNEBYANUM
UTAH	ENDANGERED	CACTACEAE	ECHINOCEREUS ENGELMANNII VAR. PURPUREUS
UTAH	ENDANGERED	CACTACEAE	SCLEROCACTUS GLAUCUS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS CRONQUISTII
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS DETRITALIS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS HAMILTONII
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS HARRISONII
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS LOANUS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS LUTOSUS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS MALACOIDES
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS MINTHORNIAE VAR. GRACILIOR
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS PARDALINUS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS SAURINUS
UTAH	ENDANGERED	FABACEAE	ASTRAGALUS SERPENS
UTAH	ENDANGERED	FABACEAE	OXYTROPIS OBNAPIFORMIS
UTAH	ENDANGERED	GENTIANACEAE	FRASERA GYPSICOLA
UTAH	ENDANGERED	HYDROPHYLLACEAE	PHACELIA ARGILLACEA
UTAH	ENDANGERED	HYDROPHYLLACEAE	PHACELIA MAMMILLARENSIS
UTAH	ENDANGERED	LILIACEAE	ALLIUM PASSEYI
UTAH	ENDANGERED	ONAGRACEAE	CAMISSONIA MEGALANTHA
UTAH	ENDANGERED	PAPAVERACEAE	ARCTOMECON HUMILIS
UTAH	ENDANGERED	POLEMONIACEAE	GILIA CAESPITOSA
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM AMMOPHILUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM ARETIOIDES
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM CORYMBOSUM VAR. DAVIDSEI
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM CRONQUISTII
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM EPHEDROIDES
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM HUMIVAGANS
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM HYLOPHILUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM INTERMONTANUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM LANCIFOLIUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM LOGANUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM PELINOPHILUM
UTAH	ENDANGERED	POLYGONACEAE	ERIOGONUM ZIONIS VAR. ZIONIS
UTAH	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA AQUARIENSIS
UTAH	ENDANGERED	SCROPHULARIACEAE	CASTILLEJA REVEALII
UTAH	ENDANGERED	SCROPHULARIACEAE	PENSTEMON CONCINNUS
UTAH	ENDANGERED	SCROPHULARIACEAE	PENSTEMON DECURVUS
UTAH	ENDANGERED	SCROPHULARIACEAE	PENSTEMON GRAHAMII
UTAH	ENDANGERED	SCROPHULARIACEAE	PENSTEMON NANUS
UTAH	THREATENED	APIACEAE	CYMOPTERUS BASALTICUS
UTAH	THREATENED	APIACEAE	CYMOPTERUS COULTERI
UTAH	THREATENED	APIACEAE	CYMOPTERUS NEWBERRYI
UTAH	THREATENED	APIACEAE	CYMOPTERUS ROSEI
UTAH	THREATENED	APIACEAE	LOMATIUM MINIMUM
UTAH	THREATENED	ASCLEPIADACEAE	ASCLEPIAS CUTLERI
UTAH	THREATENED	ASCLEPIADACEAE	ASCLEPIAS RUTHIAE
UTAH	THREATENED	ASTERACEAE	ERIGERON ABAJOENSIS
UTAH	THREATENED	ASTERACEAE	ERIGERON CRONQUISTII
UTAH	THREATENED	ASTERACEAE	ERIGERON GARRETTII
UTAH	THREATENED	ASTERACEAE	ERIGERON MANCUS
UTAH	THREATENED	ASTERACEAE	HAPLOPAPPUS SCOPULORUM
UTAH	THREATENED	ASTERACEAE	HYMENOPAPPUS FILIFOLIUS VAR. TOMENTOSUS
UTAH	THREATENED	ASTERACEAE	MACHAERANTHERA GRINDELIOIDES VAR. DEPRESSA
UTAH	THREATENED	ASTERACEAE	PARTHENIUM LIGULATUM
UTAH	THREATENED	ASTERACEAE	SENECIO DIMORPHOPHYLLUS VAR. INTERMEDIUS
UTAH	THREATENED	BORAGINACEAE	CRYPTANTHA BARNEBYI
UTAH	THREATENED	BORAGINACEAE	CRYPTANTHA COMPACTA
UTAH	THREATENED	BORAGINACEAE	CRYPTANTHA ELATA
UTAH	THREATENED	BORAGINACEAE	CRYPTANTHA SEMIGLABRA
UTAH	THREATENED	BORAGINACEAE	CRYPTANTHA STRICTA
UTAH	THREATENED	BORAGINACEAE	MERTENSIA VIRIDIS VAR. CANA
UTAH	THREATENED	BORAGINACEAE	MERTENSIA VIRIDIS VAR. DILATATA
UTAH	THREATENED	BRASSICACEAE	ARABIS DEMISSA VAR. LANGUIDA
UTAH	THREATENED	BRASSICACEAE	ARABIS DEMISSA VAR. RUSSEOLA
UTAH	THREATENED	BRASSICACEAE	ARABIS SHOCKLEYI

STATE LISTS OF ENDANGERED AND THREATENED SPECIES OF THE CONTINENTAL UNITED STATES

STATE	STATUS	FAMILY	SPECIES
UTAH	THREATENED	BRASSICACEAE	DRABA SOBOLIFERA
UTAH	THREATENED	BRASSICACEAE	DRABA SUBALPINA
UTAH	THREATENED	BRASSICACEAE	DRABA ZIONENSIS
UTAH	THREATENED	BRASSICACEAE	LESQUERELLA GARRETTII
UTAH	THREATENED	BRASSICACEAE	LESQUERELLA RUBICUNDULA
UTAH	THREATENED	BRASSICACEAE	PARRYA NUDICAULIS
UTAH	THREATENED	CACTACEAE	OPUNTIA WHIPPLEI VAR. MULTIGENICULATA
UTAH	THREATENED	CACTACEAE	SCLEROCACTUS PUBISPINUS
UTAH	THREATENED	CACTACEAE	SCLEROCACTUS SPINOSIOR
UTAH	THREATENED	CACTACEAE	SCLEROCACTUS WRIGHTIAE
UTAH	THREATENED	CARYOPHYLLACEAE	ARENARIA STENOMERES
UTAH	THREATENED	CARYOPHYLLACEAE	SILENE PETERSONII
UTAH	THREATENED	EUPHORBIACEAE	EUPHORBIA NEPHRADENIA
UTAH	THREATENED	FABACEAE	ASTRAGALUS AMPULLARIUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS CHLOODES
UTAH	THREATENED	FABACEAE	ASTRAGALUS CONVALLARIUS VAR. FINITIMUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS COTTAMII
UTAH	THREATENED	FABACEAE	ASTRAGALUS DESPERATUS VAR. CONSPECTUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS DUCHESNENSIS
UTAH	THREATENED	FABACEAE	ASTRAGALUS ENSIFORMIS
UTAH	THREATENED	FABACEAE	ASTRAGALUS LANCEARIUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS NIDULARIUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS OOPHORUS VAR. LONCHOCALYX
UTAH	THREATENED	FABACEAE	ASTRAGALUS RAFAELENSIS
UTAH	THREATENED	FABACEAE	ASTRAGALUS STRIATIFLORUS
UTAH	THREATENED	FABACEAE	ASTRAGALUS WETHERILLII
UTAH	THREATENED	FABACEAE	DALEA THOMPSONAE
UTAH	THREATENED	FABACEAE	LUPINUS MARIANUS
UTAH	THREATENED	FABACEAE	PARRYA RYDBERGII
UTAH	THREATENED	FABACEAE	PETERIA THOMPSONIAE
UTAH	THREATENED	FABACEAE	PSORALEA EPIPSILA
UTAH	THREATENED	FUMARIACEAE	CORYDALIS CASEANA SSP. CASEANA
UTAH	THREATENED	GERANIACEAE	GERANIUM MARGINALE
UTAH	THREATENED	HYDROPHYLLACEAE	NAMA RETRORSUM
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA ANELSONII
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA CEPHALOTES
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA CONSTANCEI
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA DEMISSA VAR. HETEROTRICHA
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA HOWELLIANA
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA INDECORA
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA RAFAELENSIS
UTAH	THREATENED	HYDROPHYLLACEAE	PHACELIA UTAHENSIS
UTAH	THREATENED	ONAGRACEAE	CAMISSONIA PARRYI
UTAH	THREATENED	ONAGRACEAE	EPILOBIUM NEVADENSE
UTAH	THREATENED	POACEAE	PUCCINELLIA PARISHII
UTAH	THREATENED	POLEMONIACEAE	GILIA MCVICKERAE
UTAH	THREATENED	POLEMONIACEAE	PHLOX CLUTEANA
UTAH	THREATENED	POLEMONIACEAE	PHLOX GLADIFORMIS
UTAH	THREATENED	POLEMONIACEAE	PHLOX GRAHAMII
UTAH	THREATENED	POLEMONIACEAE	PHLOX JONESII
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM CLAVELLATUM
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM FREMICUM
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM JAMESII VAR. RUBICOLA
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM NANUM
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM OSTLUNDII
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM PANGUICENSE VAR. ALPESTRE
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM SAURINUM
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM SMITHII
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM THOMPSONAE VAR. ALBIFLORUM
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM THOMPSONAE VAR. THOMPSONAE
UTAH	THREATENED	POLYGONACEAE	ERIOGONUM VIRIDULUM
UTAH	THREATENED	PORTULACACEAE	LEWISIA MAGUIREI
UTAH	THREATENED	PRIMULACEAE	PRIMULA MAGUIREI
UTAH	THREATENED	PRIMULACEAE	PRIMULA SPECUICOLA
UTAH	THREATENED	SCROPHULARIACEAE	CASTILLEJA PARVULA VAR. PARVULA
UTAH	THREATENED	SCROPHULARIACEAE	CASTILLEJA SCABRIDA
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON ABIETINUS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON ACAULIS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON CAESPITOSUS VAR. SUFFRUTICOSUS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON COMPACTUS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON LEIOPHYLLUS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON PARVUS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON UINTAHENSIS
UTAH	THREATENED	SCROPHULARIACEAE	PENSTEMON WARDII
UTAH	THREATENED	VIOLACEAE	VIOLA CHARLESTONENSIS

APPENDIX II-13

Birds of Prey and Vultures of the Kaiparowits Plateau

APPENDIX II-13

Wildlife

Birds of Prey and Vultures of the Kaiparowits Plateau*

* Includes species outside of plant-mine site impact area but within the larger area of secondary project influence.

COMMON NAME	SCIENTIFIC NAME
Hawks	
goshawk	Accipiter gentilis
sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
red-tailed hawk	Buteo jamaicensis
red-shouldered hawk	Buteo lineatus
Swainson's hawk	Buteo swainsoni
rough-legged hawk	Buteo lagopus
ferruginous hawk	Buteo regalis
golden eagle	Aquila chrysaetos
bald eagle	Haliaeetus leucocephalus
marsh hawk	Circus cyaneus
prairie falcon	Falco mexicanus
peregrine falcon	Falco peregrinus
merlin (pigeon hawk)	Falco columbarius
kestrel (sparrow hawk)	Falco sparverius
Vultures	
turkey vulture	Cathartes aura
Owls	
screech owl	Otus asio
flammulated owl	Otus flammeolus
great horned owl	Bubo virginianus
pygmy owl	Glaucidium gnoma
burrowing owl	Speotyto cunicularia
spotted owl	Strix occidentalis
long-eared owl	Asio otus
short-eared owl	Asio flammeus
saw-whet owl	Aegolius acadicus
barn owl	Tyto alba

APPENDIX II-14

Checklist of Birds of the Kaiparowits Plateau

APPENDIX II-14

Wildlife

Checklist of Birds of the Kaiparowits Plateau

(List includes species found outside of plant/mine site impact area but within the larger area of secondary influence. A few species recorded along the Colorado River before inundation by Lake Powell may no longer be present. List of species based on "Checklist of the Avifauna of the Kaiparowits Region," by Stewart Atchison, Museum of Northern Arizona.)

P -- Permanent resident	F = Recent Field Studies - (since 1964 when Lake Powell began billing)
S -- Summer resident	
W -- Winter resident	L = Literature Review - studies before Lake Powell
T -- Transient or migrant	

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon-Juniper	Habitats Outside Impact Area
Loons								
common loon	T	L						
Grebes								
eared grebe	T	F						
western grebe	T	F						
pied-billed grebe	T	F						
Pelicans								
white pelican	T	L						
Cormorants								
double-crested cormorant	T	L						
Herons and Bitterns								
great blue heron	ST			F				
great egret	W			F				
snowy egret	T			L				
black-crowned night heron	T			L				
American bittern	T			L				

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Ibises and Spoonbills								
white-faced ibis	T	L						
Swans, Geese, and Ducks								
Canada goose	T	F						
snow goose	T	L						
mallard	WT	F						
gadwall	WT	F						
pintail	WT	L						
green-winged teal	WT	L						
blue-winged teal	T	L						
cinnamon teal	T	F						
American widgeon	T	L						
shoveler	T	L						
ring-necked duck	T	F						
canvasback	WT	L						
lesser scaup	W	L						
common goldeneye	T	F						
bufflehead	T	F						
ruddy duck	T	L						
common merganser	WT	L						
American Vultures								
turkey vulture	S		F			F		
Birds of Prey								
goshawk	S			F				
sharp-shinned hawk	P		F					F
Cooper's hawk	P		F					F
red-tailed hawk	P		F					F
Swainsons's hawk	S		F			F		
ferruginous hawk	P		F			F		
golden eagle	P		F					F
bald eagle	W	F		F	F			
marsh hawk	P	F					F	

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Habitat Type Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Birds of Prey (continued)								
prairie falcon	P		F					F
peregrine falcon	ST				F		F	F
merlin (pigeon hawk)	WT		F		F		F	
American kestrel (sparrow hawk)	P		F					F
screech owl	P			L				
flammulated owl							L	L
great horned owl	P			F	F			
pygmy owl	P						L	
burrowing owl	S					L		
spotted owl	P			F			F	F
long-eared owl	P			L				
short-eared owl		L		L		L		
saw-whet owl				L				
Grouse								
blue grouse	P							L
sage grouse	P							L
Quails and Pheasants								
Gambels quail	P		F					F
chukar	P		F			F		
Turkeys								
turkey	P							F
Rails, Gallinules, and Coots								
Virginia rail	T	L						
sora rail	T	L						
yellow rail	T	F						
American coot	ST	F						

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Habitat Type Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Plovers								
killdeer	P	F		F				
Snipe and Sandpipers								
common snipe	T	L						
long-billed curlew	T			L				
spotted sandpiper	T	L		L				
solitary sandpiper	T			L				
willet	T			L				
greater yellowlegs	T			L				
lesser yellowlegs	T			L				
Baird's sandpiper	T			L				
least sandpiper	T			L				
long-billed dowitcher	T			L				
western sandpiper	T			L				
Avocets and Stilts								
American avocet	T			L				
Phalaropes								
red phalarope	T							
Wilson's phalarope	T	F		F				
northern phalarope	T	F						
Gulls and Terns								
California gull	T			F				
ring-billed gull	T			L				
Franklin's gull	T			L				
Bonaparte's gull	T			L				
Forster's tern	T	L						
black tern	T			L				

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Pigeons and Doves								
band-tailed pigeon	S						F	
mourning dove	S		F		F		F	F
Cuckoos and Roadrunners								
yellow-billed cuckoo	S			L				
roadrunner	P					L		
Goatsuckers								
poor-will	S			F		F		
common nighthawk	S					F	F	
Swifts								
white-throated swift	S					F	F	
Hummingbirds								
black-chinned hummingbird	S			F		L		
Costa's hummingbird	S							
broad-tailed hummingbird	S		L					L
rufous hummingbird	T		L					L
Allen's hummingbird	T							
calliope hummingbird	T			L		L		
Kingfishers								
belted kingfisher	T	L		L				
Woodpeckers								
common flicker	P		F	F	F			F
Lewis' woodpecker	S							F
yellow-bellied sapsucker	P			F				F
Williamson's sapsucker	ST			L				L
hairy woodpecker	P			L			L	L
downy woodpecker				L			L	L

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Tyrant Flycatchers								
eastern kingbird			L					
western kingbird	S			F				
Cassin's kingbird	S			L				
ash-throated flycatcher	S			L			L	
black phoebe	P			L		L		
Say's phoebe	S					F		
Traill's flycatcher	S			L		L		
dusky flycatcher	S			L				
gray flycatcher	ST			L				
western flycatcher				L			L	L
western wood pewee	ST			F			F	F
olive sided flycatcher	ST	F		L			L	L
Larks								
horned lark	P		F			F		
Swallows								
violet-green swallow	S	F	F	F	F	F	F	F
tree swallow	T			L				
bank swallow	T			L				
rough-winged swallow	ST			F				
barn swallow	T			L				
cliff swallow	S				L			
Jays, magpies, and crows								
Steller's jay	P						L	L
scrub jay	P					F	F	
common raven	P		F	F	F	F	F	F
common crow	T		F	F	F	F	F	F
pinyon jay	P						F	
Clark's nutcracker	P						F	F

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Titmice, Verdins, and Bushtits								
black-capped chickadee	W			L			L	L
mountain chickadee	P			F			F	F
plain titmouse	P						F	
bushtit	P			F			F	F
Nuthatches								
white-breasted nuthatch	P						L	L
red-breasted nuthatch	P						L	L
pygmy nuthatch	P						L	L
Creepers								
brown creeper	P						L	L
Dippers								
dipper	P	L		L				
Wrens								
house wren	P						L	L
Brewick's wren	P			L		L	L	
long-billed marsh wren	T	L		F	F			F
canyon wren	P			F	F			F
rock wren	S				F	F	F	F
Mockingbirds and Thrashers								
mockingbird	P		F			F	F	
grey catbird	ST			F		F		
Bendire's thrasher								
sage thrasher	S		F			F		

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Thrushes, Solitaires, & Bluebirds								
American robin	P			F			F	F
hermit thrush	ST			F			F	F
Swainson's thrush	T			F				F
western bluebird	PT			F		F	F	F
mountain bluebird	PT					F	F	F
Townsend's solitaire	P			L	L			L
Old World Warblers, Gnatcatchers, and Kinglets								
blue-gray gnatcatcher	S			F		F	F	F
golden-crowned kinglet	W			F			F	F
ruby-crowned kinglet	P			F			F	F
Wagtails and Pipits								
water pipit	WT					L		
Waxwings								
Bohemian waxwing	W						F	
Silky Flycatchers								
phainopepla	S			L		L		
Shrikes								
northern shrike	W					L		
Loggerhead shrike	P						F	F
Starlings								
starling	P		F	F	F	F	F	F

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
	Habitat Type							
Vireos								
solitary vireo	ST			F				F
warbling vireo	ST			L				L
Wood Warblers								
orange-crowned warbler	T			L				
Nashville warbler	T			L				L
Virginia's warbler	T			F				F
Lucy's warbler	S			L				
yellow warbler	ST			L				L
yellow rumped warbler	ST			F			F	F
black-throated gray warbler	S						F	
Townsend's warbler	T			L				L
hermit warbler	T							L
Grace's warbler	S						F	F
northern waterthrush	T			L				
MacGillivray's warbler	T			F				
yellowthroat	S	L		L				
yellow-breasted chat	S			L				
Wilson's warbler	T			L				L
Weaver Finches								
house sparrow	P							F
Meadowlarks, Blackbirds, Orioles								
bobolink	T			L				
western meadowlark			F			F		
yellow-headed blackbird	T			L				
redwinged blackbird				L				
Scott's oriole	S			L		L	L	
northern oriole	S			L				
Brewer's blackbird	T		L	L		L		
brown-headed cowbird	ST			F		F	F	F

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
	Habitat Type							
Grosbeaks, Finches, Sparrows, and Buntings								
black-headed grosbeak	ST			F		F	F	F
blue grosbeak	S			F		F		
lazuli bunting	ST		F		F	F	F	F
evening grosbeak	T							F
Cassin's finch	ST			F				F
house finch	P			F	F	F	F	
black rosy finch	W		F			F		
pine siskin				F			F	F
American goldfinch	P			F		F		
lesser goldfinch	P			F			F	F
red crossbill	T						L	L
green-tailed towhee	T			F	F	F		F
rufous-sided towhee	P			L			L	L
lark bunting	T		F		F			
Savannah sparrow	ST		L	L		L	L	
vesper sparrow	ST		F	F		F	F	F
lark sparrow	S		F		F		F	
black-throated sparrow	S		F	F		F		
sage sparrow	P		F	F		F		
slate-colored junco	W			F				
dark eyed junco	ST,W			F			F	F
tree sparrow	W		F	F				
chipping sparrow	S					L	L	L
Brewer's sparrow	S		F			F	F	
Harris' sparrow	W		L	L		L		
white-crowned sparrow	WT		F	F		F		
Lincoln's sparrow	T			L				
song sparrow	W			F				
McCown's longspur	W		F					
chestnut-collared longspur	W		F					

APPENDIX II-15

Birds Observed in Immediate Vicinity of Fourmile Bench

APPENDIX II-15

Wildlife

Birds Observed in Immediate Vicinity of Fourmile Bench

bluebirds, mountain

dove, mourning

finch, house

flicker, common

flycatcher, ash-throated

gnatcatcher, blue-gray

hawk, red-tailed

American kestrel (hawk, sparrow)

hummingbird, ruby-throated

jay, pinyon

lark, horned

mockingbird

nighthawk

oriole, Scott's

owl, great horned

shrike, loggerhead

sparrow, black-throated

sparrow, chipping

sparrow, Brewer's

sparrow, sage

swallow, violet-green

swift, white-throated

vireo, grey

APPENDIX II-16

Invertebrates of Kaiparowits Plateau

APPENDIX II-16

Wildlife

Invertebrates of Kaiparowits Plateau[a]

DATA CODE KEY

Area	Major Habitat Type	Where Found in Habitat
A - Lee's Ferry	I - Shrub steppe	1 - Cow chip
B - Tibbet Springs	II - Grassland	2 - Under rock
C - Nipple Springs	III - Juniper woodland	3 - On plant
D - Lake Powell Shore	IV - Coniferous forest	4 - Water trough
E - Page	V - Aquatic	5 - Pond
F - Wahweap Creek	VI - Tamarisk	6 - Seep
G - Navajo Mountain		7 - Litter
H - Cottonwood Canyon		8 - Inside Plant
J - Waterline	Life Stage	9 - On soil substrate
k - Tibbet Canyon		10 - On shoreline
L - Gypsumweed Pond	a - adult	11 - Log
M - Powerline	n - nymph	12 - Carrion
	l - larvae	13 - Man-made structure
	d - dead*	14 - Moss
		15 - In flight

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[a] Compiled by Northern Arizona University.

INSECTA (Class)

HEMIPTERA (Order).....Bugs

Veliidae (Family)
Velia sp.   CV6a

Gerridae (Family).....Water Striders
Gerris remigis   CV6a

Salididae (Family).....Shore Bugs   DI10a, DI11a, EI10n, DV5a, EI3a, DI3a, HI3a

Miridae (Family).....Leaf Bugs or Plant Bugs
Numerous species collected, not yet identified   AVI3a, EI10n, HI3n, HI3a

Corixidae (Family).....Water Boatmen
Hesperocorixa vulgaris   EV5n
Hesperocorixa laevigata   CV6a, BV6a
Graptocorixa abdominalis   EV5a, EV4a
Corisella inscripta   EV5a, DV5n, EV4a

Cydnidae (Family).....Burrowing Bugs   MI2d, MI8d

Notonectidae (Family).....Back Swimmers
Notonecta kirbyi   EV4a, BV6a
Notonecta undulata   BV6a

Scutelleridae (Family).....Shield-Backed Bugs   MI8d

Lygaedae (Family)
spp. unidentified   AVI9a
Geocoris sp.   EI9n, EI9a, EI3s

HYMENOPTERA (Order).....Bees and Wasps

Formicidae (Family).....Ants
Numerous species collected, not yet identified   AVI3a, GIV7a, EI1a, FI9a, GIV7a, HI9a, AVI2a, DI9a, EI9a, MI1d, JI1d, JI2d

Pteromalidae (Family).....Parasitic Wasps   HI3a

Ceraphronidae (Family).....Hyperparasitic Wasps   EI3a

Halictidae (Family).....Mining Bees   FI9a, HI3a

Mymeridae (Family).....Fairy Flies   AVI7a

HOMOPTERA (Order)

Cicadellidae (Family).....Leafhoppers   EI3a, AVI3a, DI3a

Aphididae (Family).....Plant Lice or Aphids   BI5a, AVI3a, EI3a

Coccidae (Family).....Scale Insects   AVI7n

Fulgoridae (Family).....Planthoppers   AVI2n

Psyllidae (Family).....Jumping Plant Lice
Pachypsylla ap.   MI8a

NEUROPTERA (Order)

Hemerobiidae (Family)   EI4d

ORTHOPTERA (Order)

Gryllidae (Family).....Crickets

Nemobilnae (Subfamily)
Nemobius sp.   AVI2a, EI2a

Acrididae (Family).....Shorthorned Grasshoppers

Acridinae (Subfamily)   EI2a

Oedipodinae (Subfamily)   EI2a

Blattidae (Family).....Cockroaches
Arenivagia sp.   BI7a

Gryllacridae (Family)

Stenopelmatinae (Subfamily).....Jerusalem Cricket   GIV9d

COLEOPTERA (Order)

Chrysomelidae (Family).....Leaf Beetles
Orsodacne sp.   HI3a

Nitidulidae (Family).....Sap Beetles   MI12a

Cleridae (Family)
Necrobia rufipes.....Red Legged Ham Beetle   MI12a

Staphylinidae (Family).....Rove Beetles
Dianous sp.   HI3a, DI2a, MI1d
Trichophys sp.   EI2a
Hybrocerus sp.   DI2a

COLEOPTERA (cont'd)

Aleocharinae (Subfamily) DV5a

Hydrophilidae (Family).....Water Scavenger Beetles
- *Enochrus* sp. KV6a, BV6a
- *Laccobius* sp. BV6a, CV6a
- *Tropisternus* sp. DV5a, BV6a
- *Helochares* sp. BV6a, CV6a
- *Berosus* sp. EV5a

Carabidae (Family).....Ground Beetles
- Numerous species, not yet identified DV5a, EI2a, AVI2a, AVI2a, HI11a

Heteroceridae (Family).....Varigated Mud-Loving Beetles
- *Heterocerus* sp. EV10a, CV14a

Coccinellidae (Family).....Ladybird Beetles
- *Adalia bipunctatia* EI3L
- spp. unidentified EI3a

Tenebrionidae (Family).....Darkling Beetles
- *Gonasida* sp. DI2a, AVI9a
- *Eleodes* sp. EI9a, GIV7a, AVI2a, MI1d, MI8d
- *Pelecyphorus* sp. JI1d
- *Eusattus* sp. MI8d, MI1d
- *Triorophus* sp. MI8a
- *Trogloderus* sp. MI1d, MI8d
- *Chilometropon* sp. MI1d
- *Edrotes* sp. JI1d

Dytiscidae (Family).....Predaceous Diving Beetles
- *Deronectes* sp. CV6a, BV6a
- *Hydroporus* sp. KV6a, BV6a, CV6a
- *Laccophilus* sp. BV6a
- *Agabus* sp. CV5L, CV6a
- *Hygrotus* sp. EV5a

Monommidae (Family) MI8a

Scarabaeidae (Family).....Dung Beetles
- Numerous species, not yet identified VI2d, FI9d, EI2d, MI1d

Anthicidae (Family).....Antlike Flower Beetles
- *Anthicus* sp. AVI2a

Lampyridae (Family).....Fireflies
- *Photinus* sp. AVI2L

COLEOPTERA (cont'd)

Silvanidae (Family).....Flat Grain Beetles
- *Oryzaephilus* sp. AVI10a

Buprestidae (Family).....Metallic Wood-Boring Beetles
- *Acmaeopera* sp. EI8L
- spp. unidentified MI8L

Curculionidae (Family).....Snout Beetles
- *Pissodes* sp. GIV7L
- *Leptopiinae* MI1a
- *Rhyncophorinae* MI7d, MI8d, MI1d
- *Thylacitinae* MI8d

Melyridae (Family).....Soft-winged Flower Beetles
- *Malachius* sp. AVI7a

Limnebiidae (Family).....Minute Moss Beetles
- *Octhebius puncticollis* EV14a, CV14a

Elateridae (Family).....Click Beetles
- spp. unidentified AVI2a, MI1a, GIV7L
- *Aphricus* sp. MI1a

Cisidae (Family).....Minute Tree-Fungus Beetles GIV7L

Dermestdae (Family)
- *Dermestes* MI12a

DIPTERA (Order).....Flies

- spp. unidentified DI3a, EI3a, AVI3a, AVI15a

Chironomidae (Family).....Midges
- spp. unidentified CV10a
- *Chironomous plumosus* DV5L, BV6L
- *Tendipes* sp. DV5L, EV4L, BV6L
- *Paratendipes* sp. KV6L
- *Diamesa* sp. BV6L
- *Brillia* sp. AI3a, CV6L
- *Cardiocladius* sp. KV6L
- *Spaniotoma* sp. GIV7L
- *Procladius* sp. EV4L, BV6L
- *Pentaneura* sp. CV6L

Muscidae (Family) BI3a

Heleomyzidae (Family) MI15a

DIPTERA (cont'd)

Culicidae (Family).....Mosquitoes
Culiseta inornata BV6L
Culiseta impatiens BV6L
spp. unidentified AVI3a, EV4d

Ephydridae (Family).....Shore Flies
Neoscatella sp. KV6L

Ceratopogonidae (Family).....Biting Midges or No-See-Ums
Culicoides sp. KV6L
Dasyhelea sp. CV6L, KV6L

Dolichopodidae (Family).....Long-Legged Flies CV6L, EV5L

Calliphoridae (Family).....Blow Flies
Lucilia illustris EI12L

Trupaneidae (Family).....Fruit Flies EI1L

Cecidomyidae (Family).....Gall Gnats
Contarinia sp. GIV7L
Lestodiplosis sp. GIV7L, GIV7a
Miaster sp. GIV7L

Drosphilidae (Family).....Small Fruit Flies GIV7L

Sarcophgidae (Family).....Flesh Flies
Sarcophaga securifera EI12L

LEPIDOPTERA (Order).....Moths and Butterflies

Plutellidae (Family).....Diamond-Back Moths HI7L

Unidentified spp. (Family) DI3a, EI3a, HI3a

Nictuidae (Family)
Laphygma exigua DI2L, AVI2L
Chorizagrotis auxiliaris AV12L
spp. unidentified AVI2L, MI1L, AVI11L

Pyralidae (Family).....Snout Moths
Pyrausta ainsliei AV12L
spp. unidentified CV14L

Arctiidae (Family).....Tigermoths GIV7L

Lyonetiidae (Family) EI8L

Gelechiidae (Family) AVI7L

COLLEMBOLA (Order).....Spring Tails

Poduridae (Family)
Achorutes sp. AVI7a
spp. unidentified AVI7a

Entomobryidae (Family)
Isotomurus sp. AVI7a
spp. unidentified GIV7a

PSOCOPTERA (Order).....Book Lice

Liposcelidae (Family) AVI7a

Psocidae (Family) AVI7a

ODONATA (Order).....Dragonflies and Damselflies

Libellulidae (Family).....Common Skippers
Tarnetrum sp. EV4n
Belonia sp. LV5n
Pantala sp. EV4n

Coenagrionidae (Family).....Narrow-winged Damselflies
Hyponeura lugens BV5n
Ischnura perparva BV5n

THYSANURA (Order).....Bristletails

Lepismatidae (Family).....Silverfish EI1n

THYSANOPTERA (Order).....Thrips

Thripidae (Family).....Common Thrips AVI7a, GIV7a

Phloeothripidae (Family) AVI7a

ISOPTERA (Order).....Termites

Rhinotermitidae (Family) AVI11a

Termitidae (Family) JI11a

EPHEMEROPTERA (Order).....Mayflies

Baetidae (Family).....Small Mayflies
Paraleptophlebia sp. CV6n
Callibaetis sp. BV5n, EV4n, KV6n
Cloeon sp. BV5n, LV5n
Beatis sp. LV5n
Baetodes sp. EV4n

TRICHOPTERA (Order).....Caddisflies

Limnephilidae (Family).....Northern Caddisflies
   Limnephilus sp. BV5n, CV5n

ARACHNIDA (Class)

SOLPUGIDA (Order).....Sunspider

Eremobatidae (Family) JI2n

SCORPIONIDA (Order).....Scorpions

Vejovidae (Family)
   Vejovis flavus DI1a
   Anuroctonus sp. MI2a

Buthidae (Family)
   Centruroides sculpturatus AIV2a

PHALANGIDA (Order).....Daddy Long-Legs

halangidae (Family)
   Lacinius sp. JI2n

ARANEIDA (Order).....Spiders

Clubionidae (Family)
   Phrurolithus sp. EI2a

Anyphaenidae (Family)
   Anyphaena sp. DI2a

Therididae (Family)
   Lythyphantes sp. EI1a
   spp. unidentified HI3a, MI2a

Lycosidae (Family).....Wolf Spiders
   Trochosa sp. CI10a
   Pardosa sp. DI3a, DI11a, DI1a, CI10a, HI10a, AVI2a
   Schizocosa sp. AVI2a

Araneidae (Family)
   Mongora sp. DI3a

Pholcidae (Family)
   Psilochorus sp. DI1a, JI2a, MI1a

ARANEIDA (cont'd)

Micryphantidae (Family) GIV7a

Plectreuridae (Family)
   Plectreurys sp. EI1a, MI1a, JI2a

Thomisidae (Family).....Crab Spiders
   Ebo sp. AVI13a
   Philodromus sp. AVI13a, AVI2a, FVI1a
   Misumenops sp. GIV7a, MI12a, MI2a
   Synema sp. EI1a
   Thanatus sp. MI1a

Agelenidae (Family)
   Cicurina robusta FVI1a

Gnaphosidae (Family)
   Gnaphosa sp. EI1a, FVI1a
   Sergidlus sp. AVI2a
   Haploorassus sp. FVI1a, MI1a

Dictynidae (Family)
   Dictyna sp. DI3a

Tetragnathidae (Family)
   Tetragnatha sp. AVI3a

Filistatidae (Family)
   Filistata sp. MI2a

ACARI (Subclass).....Mites

ACARIFORMES (Order)

Caeculidae (Family) AVI7a

Damaeidea (Family) AVI7a, GIV7a

Bdellidae (Family) AVI7a

Euphthiracaridae (Family) AVI7a

Eremaeidae (Family) AVI7a, GIV7a

Oribatellidae (Family) AVI7a, GIV7a

Trombidiidae (Family) AVI7a, GIV7a

ACARIFORMES (cont'd)

Neophyllobiidae (Family) AVI7a

Cymbaeremaeidae (Family) AVI7a

Cheyledidae (Family) AVI7a

Camisiidae (Family) AVI7a

PARASITIFORMES (Order)

Discourellidae (Family) AVI7a

Rhodacaridae (Family) AVI7a

Pachylaelapidae (Family) AVI7a

CRUSTACEA (Class)

COPEPODA (Subclass)

EUCOPEPODA (Order).....Copepods

Cyclopidae (Family) LV5a

OSTRACODA (Subclass)

PODOCOPA (Order).....Seed Shrimp

Cypridae (Family) DV5a, EV4a

CHILOPODA (Class).....Centipedes

ANAMORPHA (Subclass)

LITHOBIOMORPHA (Order)

Henicopidae (Family) AV12a

Lithobiidae (Family) GIV7a

Following is a list of insects previously reported in the Kaiparowits Basin.

Those insects in the list whose presence we have confirmed in our collecting are preceded by a letter. The letter used indicates the taxonomic level to which they have been confirmed, i.e.:

(F) Confirmed to family

(G) Confirmed to genus

(S) Confirmed to species

The insects in the following list were collected as incidentals by O. King in 1958 while he worked as a member of a crew surveying the vegetation of the Kaiparowits Basin. The specimens were identified by Beng C. Ho of the University of Utah Museum.

TERRESTRIAL INSECTS

ORTHOPTERA (Order).....Grasshoppers, crickets and allies

(F) Acrididae (Family).....Short-horned grasshoppers
Crytacanthacridinae sp.

Tettigoniidae (Family).....Long-horned grasshoppers

HEMIPTERA (Order).....Bugs

Pentatomidae (Family).....Stink bugs
Chlorochroa sp.

Reduviidae (Family).....Kissing bugs

COLEOPTERA (Order).....Beetles

Cerambycidae (Family).....Long-horned beetles
Prionus californicus

(F) Chrysomelidae (Family).....Leaf beetles
Nodonota puncticollis

COLEOPTERA (cont'd)

(F) Scarabeidae (Family).....June beetles
Polyphylla crinata

(F) Carabidae (Family).....Ground beetles

Pselaphidae (Family).....Ant-loving beetles

Coccinellidae (Family).....Ladybird beetles
Hippodamia convergens

Mordellidae (Family).....Tumbling flower beetles
Mordella sp.

LEPIDOPTERA (Order).....Butterflies and Moths

Nymphalidae (Family).....Brush-footed butterflies
Argynnis eurynome

Danaidae (Family).....Milkweed butterflies
Danaus plexippus

Satyridae (Family).....Satyrs

DIPTERA (Order).....Flies

(F) Culicidae (Family).....Mosquitoes
Aedes vexans

(F) Dolichopodidae (Family).....Long-legged flies

Nemestrinidae (Family).....Nemestrinids
Hyrmophloeba sp.

Asilidae (Family).....Robber flies
Pseudorus sp.

(F) Sarcophagidae (Family).....Flesh flies
Hystricocnema plinthopyga

Pipunculidae (Family).....Big-eyed flies

Bombyliidae (Family).....Bee flies
Anthrax tigrina

HYMENOPTERA (Order).....Bees, Wasps, Ants and Allies

Pompilidae (Family).....Spider wasps
Pepsis sp.

HYMENOPTERA (cont'd)

Apidae (Family).....Bumble bees
Bombus terricola
Bombus impatiens
Bombus borealis

Sphecidae (Family).....Sphecid - wasps
Sphecius grandis
Sphecinae sp.
Nyssininae sp.
Philanthinae sp.

Vespidae (Family).....Vespid wasps
Polistes texanus
Eumeninae sp.

Megachilidae (Family).....Leaf-cutter bees
Callanthidium sp.

Mutillidae (Family).....Velvet ants
Dasymutilla klugii

Tiphiidae (Family)

(F) Halictidae (Family).....Sweat bees
Sphecodes sp.

(F) Formicidae (Family).....Ants
Pognomyrex occidentalis comanche
Myrmecocystus mexicanus hortideorum

AQUATIC INSECTS

EPHEMEROPTERA (Order).....Mayflies

Oligoneuriidae (Family)
Homoeoneuria sp.
Lachlania powelli
Heptagenia elegantula

Baetidae (Family)
(G) *Baetis* sp.
(G) *Callibaetis* sp.

Leptophlebiidae (Family)
Traverella albertana

Tricorythidae (Family)
Tricorythodes sp.

ODONATA (Order).....Dragonflies and Damselflies

Gomphidae (Family).....Dragonflies
- *Progomphus borealis*
- *Gomphus intricatus*

Aeshnidae (Family).....Dragonflies
- *Anax walsinghami*
- *Aeshna palmata*

Libellulidae (Family).....Dragonflies
- *Libellula comanche*
- *Libellula saturata*
- (G) *Tarnetrum corruptum*
- *Paltothemis lineatipes*
- (G) *Pantala hymenaea*

Lestidae (Family).....Damselflies
- *Archilestes grandis*

(F) Coenagrionidae (Family).....Damselflies
- *Argia emma*
- *Argia vivida*
- *Argia sedula*
- *Enallagma*

HEMIPTERA (Order).....Bugs

Corixidae (Family) Waterboatmen
- (S) *Graptocorixa abdominalis*
- (G) *Corisella tarsalis*

Notonectidae (Family).....Back swimmers
- (S) *Notonecta kirbyi*
- *Notonecta lobata*
- (S) *Notonecta undulata*
- Notonecta unifasciata

Naucoridae (Family).....Creeping water bugs
- *Ambrysus mormon*

Belostomatidae (Family)
- *Lethocerus americanus*

Gelastocoridae (Family).....Toad bugs
- *Gelastocoris oculatus*

Gerridae (Family).....Water striders
- (S) *Gerris remigis*

(F) Veliidae (Family).....Small water striders
- *Microvelia americana*

MEGALOPTERA (Order).....Alderflies, Dobsonflies, Fishflies

Corydalidae (Family).....Dobsonflies
- *Corydalus* sp.

TRICHOPTERA (Order).....Caddiceflies

Philopotamidae (Family)
- *Chimarra* sp.

Psychomyiidae (Family)
- *Polycentropus* sp.

Hydropsychidae (Family)
- *Hydropsyche* sp.
- *Potamyia* sp.

Hydroptilidae (Family)
- *Neotrichia* sp.

(F) Limnephilidae (Family)
- *Hesperophylax* sp.

Brachycentridae (Family)
- *Brachycentrus* sp.

Heliocopsychidae (Family)
- *Helicopsyche* sp.

LEPIDOPTERA (Order).....Butterflies and Moths

(F) Pyralidae (Family).....Snout moths
- *Parargyractis kearfottalis*

COLEOPTERA (Order).....Beetles

Haliplidae (Family).....Crawling water beetles
- *Peltodytes simplex*

Dytiscidae (Family).....Predaceous water beetles
- (G) *Laccophilus decipiens*
- *Bidessus* sp.
- (G) *Hygrotus* sp.
- (G) *Deronectes* sp.
- *Oreodytes* sp.
- (G) *Agabus* sp.
- *Agabus* sp.
- *Agabus lugens*
- *Rhantus anisonychus*
- *Rhantus binotatus*
- *Thermonectus marmoratus*

COLEOPTERA (cont'd)

Gyrinidae (Family).....Whirligig beetles
- *Gyrinus plicifer*

Hydrophilidae (Family).....Water scavenger beetles
- (G) *Berosus punctatissimus*
- *Berosus maculosus*
- *Berosus styliferus*
- *Hydrochara lineata*
- *Hydrophilus triangularis*
- (G) *Tropisternus ellipticus*
- (G) *Laccobius ellipticus*
- (G) *Enochrus obtusiusculus*

Dryopidae (Family).....Long-toed crawling water beetles
- *Helichus suturalis*

Elmidae (Family).....Riffle beetles
- *Microcylloepus similis*

DIPTERA (Order).....Flies

Tipulidae (Family).....Crane flies
- *Holorusia* sp.

Culicidae (Family).....Mosquitoes
- *Anopheles franciscanus*
- (G) *Culiseta incidens*
- *Culex tarsalis*
- *Culex* sp.

Simulidae (Family).....Black flies
- *Simulium* sp.
- *Simulium virgatum*

Tendipedidae (Family).....Midges (Chironomidae)
- ***Anatophnia*** **sp.**
- ***Eukiefferiella*** **sp.**
- **(G)** ***Paratendipes*** **sp.**
- ***Paratendipes albimanus***
- ***Microtendipes caducus***
- **(G)** ***Tendipes*** **sp.**
- ***Polypedilum*** **sp.**
- ***Polypedilum*** **sp.**
- ***Polypedilum*** **sp.**
- ***Tanytarsus*** **sp.**
- ***Tanytarsus*** **sp.**
- ***Calopsectra*** **sp.**
- ***Calopsectra exigua***

DIPTERA (cont'd)

Stratiomyidae (Family).....Soldier flies
- *Euparyphus* sp.
- *Stratiomys* sp.

Tabanidae (Family).....Horse flies, deer flies and allies
- *Chrysops* sp.
- *Tabanus* sp.

Empididae (Family).....Dance flies
- *Hemerodromia* sp.

(F) Ephydridae (Family).....Ephydrid flies
- *Brachydeutera* sp.

Schiomyzidae (Family).....Marsh flies
- *Dictya* sp.

APPENDIX II-17

Reptiles and Amphibians of Kaiparowits Plateau

APPENDIX II-17

Wildlife

Reptiles and Amphibians of Kaiparowits Plateau[a]

Basis for listing: F = Field studies after Lake Powell formed
L = Literature prior to Lake Powell

		Habitat Type				
SCIENTIFIC NAME	COMMON NAME	Canyon Bottom & Streamside	Rocky Slopes	Desert	Grassland	Woodland
Lizards						
Crotaphytus collaris	collared lizard		F	F		
Crotaphytus wislizenii	long-nosed leopard lizard	L		F	F	
Sauromalus obesus	chuckwalla	L	L	F		
Holbrookia maculata	speckled earless lizard			F		
Sceloporus magister	Utah spiny lizard	L	L	F		
Sceloporus undulatus	plateau lizard		L	L		
Sceloporus graciosus	Great Basin sagebrush lizard		F	L		
Uta ornata	tree lizard		L			F
Uta stansburiana	side blotched uta		L	F	F	F
Phrynosoma douglassi	short-horned lizard		L	F		
Phrynosoma platyrhinos	desert horned lizard		L	F		
Xantusia vigilis	night lizard			L		
Cnemidophorus velax	plateau whiptail	L	L	L		
Cnemidophorus tigris	whiptail		L	F		

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[a] This list includes some species recorded by earlier studies which encompassed terrain outside but adjacent to the project impact area. Also, earlier studies covered habitat along Colorado River now inundated by Lake Powell. List compiled by Northern Arizona University.

(continued)

Reptiles and Amphibians of Kaiparowits Plateau

		Habitat Type				
SCIENTIFIC NAME	COMMON NAME	Canyon Bottom & Streamside	Rocky Slopes	Desert	Grassland	Woodland
	Snakes					
Masticophis taeniatus	desert striped whipsnake	L		L		
Thamnophis cyrstopsis	black-necked garter snake	L				
Thamnophis elegans	wandering garter snake	L	L			
Salvadora hexalepsis	Mohave patch nosed snake	F	F		F	
Pituophis cantenifer	gopher snake	L	L	F	F	
Lampropeltis getulus	king snake	L		F		
Hypsiglena torquata	Mesa Verde night snake	L				
Crotalus viridus	western rattlesnake		F	F	F	F
	Turtles					
Chrysemys picta	western painted turtle	F				
	Amphibians					
Ambystoma tigrinum	tiger salamander	L				
Scaphiopus hammondi	western spadefoot toad	L				
Bufo cognatus	plains toad			F		
Bufo punctatus	red spotted toad	F				
Bufo woodhousei	Rocky Mountain toad	F				
Hyla arenicolor	canyon tree frog	L				
Pseudacris triseriata	cricket frog	L				
Rana pipiens	leopard frog	L				

APPENDIX II-18

Species List of Lake Powell Fish - Past and Present

APPENDIX II-18

Wildlife

Species List of Lake Powell Fish - Past and Present[a]

Catostomidae (Family) - Suckers
*_Catostomus latipinnis_ (Baird and Girard) - flannelmouth sucker
+*_Pantosteus delphinus_ (Cope) - Colorado River mountain sucker
*_Xyrauchen texanus_ (Abbott) - humpback sucker

Cyprinidae (Family) - Minnows
Cyprinus carpio (L.) - carp
Gila atraria (Girard) - Utah chub
+*_Gila cypha_ (Miller) - humpback chub
+*_Gila elegans_ (Baird & Girard) - bonytail chub
*_Gila robusta_ (Girard & Baird) - Colorado or roundtail chub
+*_Notropis lutrensis_ (Baird & Girard) - red shiner
Pimephales promelas (Rafinesque) - fathead minnow
*_Ptychocheilus lucius_ (Girard) - Colorado squawfish
*_Rhinichthys osculus yarrowi_ (Jordan & Everman) - Colorado speckled dace

Ictaluridae (Family) - Catfishes
Ictalurus melas (Rafinesque) - black bullhead
Ictalurus natalis (LeSuer) - yellow bullhead
Ictalurus punctatus (Rafinesque) - channel catfish

Cyprinodontidae (Family) - Killifishes
+ _Fundulus zebrionus_ (Jordan & Gilbert) - southwest plains killifish

Poeciliidae (Family) -
+ _Gambusia affinis_ (Baird & Girard) - western gambusia

Centrarchidae (Family) - Sunfishes
Lepomis cyanellus (Rafinesque) - green sunfish
Lepomis macrochirus (Rafinesque) - bluegill
Micropterus salmoides (Lacepede) - largemouth bass
# _Pomoxis nigromaculatus_ (LeSueur) - black crappie

Percidae (Family) - Perches
+ _Perca flavescens_ (Mitchill) - yellow perch
# _Stizostedium vitreum_ (Mitchill) - walleye

Salmonidae (Family) -
# _Salmo gairdneri_ (Richardson) - rainbow trout
# _Salmo trutta_ (Linnaeus) - brown trout
# _Oncorhynchus nerka_ (Kennerlyi) - kokanee

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* Native to Colorado
+ Formerly present but may no longer occur
# New species planted in Lake Powell

[a] Compiled by Northern Arizona University

APPENDIX II-19

Birds Found Along the Proposed Kaiparowits Transmission System

APPENDIX II-19

Wildlife

Birds found along the Kaiparowits transmission system

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Loons															
Common loon	Gavia immer	T												L	L
Red-throated loon	Gavia stellata	T												L	L
Grebes															
Horned grebe	Podiceps auritus	T												L	L
Eared grebe	Podiceps caspicus	T												L	L
Western grebe	Aechmophorus occidentalis	T												L	L
Pied-billed grebe	Polilymbus podiceps	W												L	L
Pelicans															
White pelican	Pelecanus erythrorhynchos	W												L	L
Brown pelican	Pelecanus occidentalis	S												L	L
Cormorants															
Double-creasted cormorant	Phalacrocorax auritus	W												L	L
Herons & Bitterns															
Great blue heron	Ardea herodias	W												L	L
Green heron	Butorides virescens	W												L	L
Little blue heron	Florida caerulea	W												L	L
Common egret	Casmerodius albus	W												L	L
Snowy egret	Leucophoyx thula	W												L	L
Louisiana heron	Hydranassa tricolor	W												L	L
Black-crowned night heron	Nycticorax nycticorax	W												L	L
Least bittern	Ixotorychus exilis	W												L	L
American bittern	Botaurus lengtiginosus	W												L	L
Ibises															
Wood ibis	Mycteria americana	S												L	L
White-faced ibis	Plegadis chihi	W												L	L
Swans, Geese & Ducks															
Whistling swan	Olor cdumbinaus	W												L	L
Canada goose	Branta canadensis	W												L	L
Black brant	Branta nigricans	W												L	L
White-fronted goose	Anser albifrons	W												L	L
Snow goose	Chen hyperborea	W												L	L
Ross' goose	Chen rossii	W												L	L
Fulvous tree duck	Dendrocygna bicolor	W												L	L

Birds Found Along the Kaiparowits Transmission System

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies-
(by Southern California
Edison conducted
during the summer
of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Mallard	Anas platyrhynchos	W S									L			L	
Gadwall	Anas strepera	W									L			L	
Pintail	Anas acuta	W									L			L	
Green-winged teal	Anas carolinensis	W									L			L	
Blue-winged teal	Anas discors	W									L			L	
Cinnamon teal	Anas cyanoptera	W									L			L	
American widgeon	Mareca americana	W									L			L	
Shoveler	spatula clypeata	W									L			L	
Wood duck	Aix sponsa	W									L			L	L
Redhead	Aythya americana	W												L	L
Ring-neck duck	Aythya collaris	W												L	L
Canvasback	Aythya valisineria	W												L	L
Greater scaup	Aythya marila	W												L	L
Lesser scaup	Aythya affinis	W												L	L
Common goldeneye	Bucephala clangula	W												L	L
Borrow's goldeneye	Buchephala islandica	W												L	L
Bufflehead	Buchephala albeola	W												L	L
White-winged scoter	Melanitta deglandi	W												L	L
Ruddy duck	Oxyura jamaicensis	W												L	L
Hooded merganser	Lophodytes cucullatus	W												L	L
Common merganser	Mergus merganser	W												L	L
Red-breasted merganser	Mergus serrator	W												L	L
Vultures															
Turkey vulture	Cathartes aura	P	F		F	L	F	F	L	L	L				
Hawks, Harriers & Eagles															
Goshawk	Accipiter gentilis	P	L	L	L		L	L	L	L	L				
Sharp-shinned hawk	Accipiter striatus	P	L	L	L			L	L	L	L				
Cooper's hawk	Accipiter cooperii	P	L	L	L			F	L	L	L		L		
Red-tailed hawk	Buteo jamaicensis	P	L	L	F	L	F	L	L	F	L		L		

Birds Found Along the Kaiparowits Transmission System

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Red-shouldered	Buteo lineatus	P	L							L					
Swainsons's hawk	Buteo swainsoni	P	L	L	F	L	L	L	L	L	L				
Rough-legged hawk	Buteo lagopus	P		L	L	L	L		L						
Ferruginous hawk	Buteo regalis	P		L	L	L	L	L							
Harris' hawk	Parabuteo unicinctus	P	L						L	L	L				
Golden eagle	Aguila chrysaetos	P	L	L	L	L	F	L	L	L	L				
Bald eagle	Haliaeetus leucocephalus	W			L	L	L				L				
Marsh hawk	Circus cyaneus	P		L							L			L	
Black hawk	Buteogallus anthracinus	S									A		A		
Osprey															
Osprey	Pandion haliaetus	W									L				L
Falcons															
Prairie falcon	Falco mexicanus	P		L	L	L	L				L		L		
Peregrine falcon	Falco peregrinus	W		L	L	L	L						L		
American kestrel	Falco sparverius	P	L	F	F	L	F	L	L	L	L				
Grouse															
Sage grouse	Centrocepcus urophasianus	P		L	L										
Quail, Partridge & Pheasants															
Scaled quail	Callipepla squamata	P				L	L								
California quail	Lephortyx californicus	P						F		F		L			
Gambel's quail	Lophortyx gambelii	P	F		F	L	F					L			
Mountain quail	Oreortyx pictus	P	L		L										
Ring-necked pheasant	Phasianus colchicus	P										L			
White-winged pheasant	Phasianus colchicus bianchii	P										L			
Chukar	Alectoris graeca	P	L	L									L		
Turkeys															
Turkey	Meleagris gallopavo	P	L	L											
Cranes															
Sandhill crane	Grus canadensis	W										L		L	L
Rails, Gallinules & Coots															
Virginia Rail	Rallus limicola	W									L			L	L
Sora	Porzana carolina	W									L			L	L
Common gallinule	Gallinula chloropus	W									L			L	L
American coot	Fulica americana	W									L			L	L
Plovers															
Snowy plover	Charadrius alexandrinus	T									L			L	

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Killdeer	Charadrius vociferus	W									L			L	
Mountain plover	Eupoda montana	W									L			L	
American golden plover	Plurialis dominica	T									L			L	
Snipe, Sandpipers, etc.															
Common snipe	Capella gallinago	W									L			L	
Long-billed curlew	Numenius americanus	W									L			L	
Whimbrel	Numenius phaeopus	W									L			L	
Upland plover	Bartramia longicauda	T									L			L	
Spotted sandpiper	Actitis macularia	W									L			L	
Willet	Catoptrophorus semipalmatus	W									L			L	
Greater yellowlegs	Totanus melanoleucus	W									L			L	
Lesser yellowlegs	Totanus flauipes	T									L			L	
Pectoral sandpiper	Erolia melanotos	T									L			L	
Baird's sandpiper	Erolia bairdii	T									L			L	
Least sandpiper	Erolia minutilla	W									L			L	
Dunlin	Erolia alpina	W									L			L	
Long-billed dowitcher	Limnodromus scolopaceus	W									L			L	
Stilt sandpiper	Micropalama	T									L			L	
Western sandpiper	Ereunetes mauri	W									L			L	
Marbled godwit	Limosa fedoa	W									L			L	
Sanderling	Crocethia alba	W									L			L	
Avocets & Stilts															
American avocet	Recurvirostra americana	W												L	
Black-necked stilt	Himantopus mexicanus	W												L	
Phalaropes															
Wilson's phalarope	Steganopus tricolor	T												L	
Northern phalarope	Lobipes lobatus	T												L	
Gulls & Terns															
Herring gull	Larus argentatus	W												L	L
California gull	Larus californicus	W												L	L
Ring-billed gull	Larus delawarensis	W												L	L

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Bonaparte's gull	Larus philadelphia	W												L	L
Foster's tern	Sterna foresteri	W												L	L
Least tern	Sterna albifrons	W												L	L
Caspian tern	Hydroprogne caspia	W												L	L
Black tern	Chilidonias niger	W												L	L
Pigeons & Doves															
Band-tailed pigeon	Columba fasciata	W	L						L						
Rock dove	Columba livia	P										L			
White-winged dove	Zenaida asiatica	S										L			
Mourning dove	Zenaida macroura	S	F	F	F	L	F	L	L	F	L	L			
Spotted dove	Streptopelia chinensis	P										L			
Ground dove	Columbigallina passerina	P										L			
Inca dove	Scardafella inca	P										L			
Cuckoos & Roadrunners															
Yellow-billed cuckoo	Coccyzus americanus	T									L				
Roadrunner	Geococcyx californianus	P	L		F	L	F			F					
Owls															
Barn owl	Tyto alba	P	L	L							L	L	L		
Screech owl	Otus asio	P	L								L	L	L		
Flammulated owl	Otus flammeolus	W	L												
Great horned owl	Bubo virginianus	P	L	L	L	L	L	L	L	L	L	L		L	
Snowy owl	Nyctea scandiaca	W		L							L				
Pygmy owl	Glaucidium gnoma	P	L								L		L		
Burrowing owl	Speotyto cunicularia	P		L	F		F					L			
Long-eared owl	Asio otus	S	L						L	L	L				
Short-eared owl	Asio flammeus	P		L								L			
Saw-whet owl	Aegolius acadicus	W	L												
Goatsuckers															
Whip-poor-will	Caprimulgus vociferus	P							L		L				
Poor-will	Phalaenoptilus nittallii	W	L		L	L	L						L		
Common nighthawk	Chordeiles minor	S	L	F			F	L			L				

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Lesser nighthawk	Chordeiles actipennis	S		L	F	L	F								
Swifts															
Vaux's swift	Chaetura vauxi	P											L		
White-throated swift	Aeronautes saxatalis	W	F		F		F								
Hummingbirds															
Black-chinned hummingbird	Archilochus alexandri	S			L	L	L		L		L		L		
Costa's hummingbird	Calypte costae	S			L	L	L								
Anna's hummingbird	Calypte anna	P						F		F		L			
Broad-tailed hummingbird	Selasphorus platycercus	T		L							L				
Rufous hummingbird	Selasphorus rufus	T	L								L	L			
Allan's hummingbird	Selasphorus sasin	T	L	L							L	L			
Calliope hummingbird	Stellula calliope	T	L								L	L	L		
Kingfishers															
Belted kingfishers	Megaceryle alcyon	W												L	
Woodpeckers															
Yellow-shafted flicker	Colaptes auratus	P	L	L							L	L			
Red-shafted flicker	Colaptes cater	P	L	L				F			L	L			
Gilded flicker	Colaptes chrysoides	P			L	L	L				L				
Gila woodpecker	Centurus uropygialis	P									L	L	L		
Acorn's woodpecker	Melanerpes formicivorus	P						L	L						
Lewis' woodpecker	Asyndesmus lewis	W	L								L	L			
Yellow-bellied sapsucker	Sphyrapicus varius	W	L								L	L			
Williamson's sapsucker	Sphyrapicus thyroideus	W	L								L				
Hairy woodpecker	Dendrocopos villosus	P	L								L	L			
Downy woodpecker	Dendrocopos pubescens	P	L								L	L			
Ladder-backed woodpecker	Dendrocopos scalaris	P	L								L	L			
Nuttal's woodpecker	Dendrocopos nuttalii	P	L								L	L			
Arizona woodpecker	Dendrocopos arizonae	P							L		L	L			
Tyrant Flycatchers															
Eastern kingbird	Tyrannus tyrannus	T	L						L		L	L			
Western kingbird	Tyrannus verticalis	P	L				F		L		L	L			
Cassin's kingbird	Tyrannus vociferans	S	F					L	L		L	L			

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Scissor-tailed flycatcher	*Muscivora forficata*	S					L				L	L			
Wied's crested flycatcher	*Myiarchus tyronnulus*	S							L			L			
Ash-throated flycatcher	*Myiarchus dinerascens*	S	F				F	F	L			L			
Olivaceous flycatcher	*Myiarchus tuberculifer*	S	L						L			L			
Black phoebe	*Sayornis nigricans*	P	F		F						L	L			
Say's phoebe	*Sayornis says*	W				L	F				L	L			
Traill's flycatcher	*Empidonax trillii*	P									L	L			
Least flycatcher	*Empidonax minimus*	T									L	L			
Hammond's-Ducky flycatcher	*Empidonax hammondii*	T	L								L				
Gray flycatcher	*Empidonax wrightii*	W	L		L						L				
Western flycatcher	*Empidonax difficilis*	T	L								L				
Western Wood pewee	*Contopus sordidulus*	T	L								L				
Olive-sided flycatcher	*Nuttallornis borealis*	S	L								L				
Vermillion flycatcher	*Pyrocephalus rubinus*	P					L				L				
Larks															
Horned lark	*Eremophila alpestris*	S		F	F	L	F	L							
Swallows															
Violet-green swallow	*Tachycineta thalassina*	S	L				F				L	L	L		
Tree swallow	*Iridoprocne bicolor*	W									L	L	L		
Bank swallow	*Riparia riparia*	T												L	
Rough-winged swallow	*Stelgdopteryx fulicollis*	T												L	
Barn swallow	*Hirundo rustica*	P												L	
Cliff swallow	*Petrocholidon pyrrhonota*	P		F										L	
Purple martin	*Progne subis*	P										L			
Jay, Magpies and Crows															
Steller's jay	*Cyanocitta stelleri*	P	L						L	L					
Scrub jay	*Aphelocoma coerulescens*	P	L					F	L	F		L			
Black-billed magpie	*Pica pica*	P	L	L	L	L	L	L	L	L	L	L	L		
Common raven	*Corvus corax*	P	F	F	F	L	L	F	L	L	L	L	L		
Common crow	*Corvus brachyrhynchos*	P	L	L	L	L	L	L	L	L	L	L	L		

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Pinon jay	Gymnorhinus cyanocophala	P	F	F	L		F								
Clark's nutcracker	Nucifraga columbiana	P	L												
Chickadees & Titmice															
Mountain chickadee	Parus gambeli	P	L												
Plain titmouse	Parus inornatus	P	F						L	L	L				
Verdin	Auriparus flaviceps	P						L							
Common bushtit	Psaltriparus minimus	P	F						L	L					
Nuthatches															
White-breasted nuthatch	Sitta carolinensis	R	L						L		L				
Red-breasted nuthatch	Sitta canadensis	W	L						L		L				
Pygmy nuthatch	Sitta pygmaea	R	L						L		L				
Creepers															
Brown creeper	Certhia familiaris	R	L												
Wrentits															
Wrentit	Chamaea pasciata	R								F		L			
Dippers															
Dipper (Water ousel)	Cinclus mexicanus	R												L	
Wrens															
House wren	Troglodytes aedon	W						L	L			L			
Winter wren	Troglodytes troglodytes	W	L					L	L			L		L	
Bewick's wren	Thryomanes bewickii	R	F				F	F	L	F		L			
Cactus wren	Campylorhynchus brunneicapillum	R			F	L	F								
Long-billed marsh wren	Telmatodytes palustris	W									L				
Canyon wren	Catherpes mexicanus	R		L	L	L	F						L		
Rock wren	Salpinctes obsoletus	W											L		
Mockingbirds & Thrashers															
Mockingbirds	Mimus polyglottos	T					L	F			L	L			
Catbird	Dumetella carolinensis	S						L	L		L				
Brown thrasher	Toxostoma rufum	T						L	L		L				
Bendire's thrasher	Toxostoma bendirei	T						L	L		L				
Curve-billed thrasher	Toxostoma curvirostre	P				L	F								
California thrasher	Toxostoma redivium	P						F		L	L				
LeConte's thrasher	Toxostoma locontei	P			L	L									
Crissal thrasher	Toxostoma dorsale	P			L	L					L				

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Sage thrasher	Oreoscoptes montanus	W			F	L	L								
Thrushes															
Robin	Turdus migratorius	S									L	L			
Varied thrush	Ixoreus nacvius	T	L								L				
Hermit thrush	Hylocichla guttata	W	L								L				
Swainson's thrush	Hylocichla ustulata	T	L								L				
Veery	Hylocichla fuscescens	S									L				
Western bluebird	Sialia mexicana	W	L		L	L					L	L			
Mountain bluebird	Sialia currucoides	W	L		L	L					L				
Townsend's solitaire	Myadestes townsendi	W	L		L	L			L	L	L				
Wood thrush	Hylocichla mustelina	T	L								L				
Gnatcatchers & Kinglets															
Blue-gray gnatcatcher	Polioptila caerulea	W							L	L	L				
Black-tailed gnat-catcher	Polioptila melanura	R				L	L	F	L	F					
Golden-crowned kinglet	Regulus satrapa	W	L						L	L	L				
Ruby-crowned kinglet	Regulus calendula	W	L						L	L	L				
Pipits															
Water pipit	Anthus spinoletta	W									L	L			
Waxwings															
Bohemian waxwing	Bombycilla garrula	W	L								L	L			
Cedar waxwing	Bombycilla cedrorum	W	L								L	L			
Silky Flycatchers															
Phainopepla	Phainopepla nitens	W				L	L	F	L	F					
Shrikes															
Northern shrike	Lanius excubiton	W	F	F	F	L	F								
Loggerhead shrike	Lanius lodovicianus	W	F	F	F	L	F								
Starlings															
Starling	Sturnus vulgaris	R									L	L			
Vireos															
Hutton's vireo	Vireo huttoni	R							L	L					
Bell's vireo	Vireo bellii	R					L		L	L	L				
Gray vireo	Vireo vicinior	W	F						L	L					
Solitary vireo	Vireo solitarius	W							L	L					
Warbling vireo	Vireo gilvus	R							L	L	L				
Yellow-throated vireo	Vireo flavifrons	T							L	L					

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Warblers															
Black and white warbler	Mniotilta varia	T	L						L						
Tennessee warbler	Vermivora peregrina	T							L		L				
Orange-crowned warbler	Vermivora celata	T							L		L				
Nashville warbler	Vermivora ruficapilla	T						L	L						
Virginia's warbler	Vermivora virginiae	T	L					L	L						
Lucy's warbler	Vermivora luciae	P					L				L				
Myrtle warbler	Dendroica coronata	W	L					L	L						
Audubon's warbler	Dendroica auduboni	W						L	L			L			
Black-throated gray warbler	Dendroica nigrescens	W	F					L	L						
Townsend's warbler	Dendroica townsendi	T	L					L	L						
Black-throated green warbler	Dendroica virens	T	L												
Hermit warbler	Dendroica occidentalis	T	L					L	L						
Grace's warbler	Dendroica graciae	W						L	L						
Blackpoll warbler	Dendroica striata	T	L					L	L						
Ovenbird	Seiurus aurocapillus	T						L	L						
Northern waterthrush	Seiurus noveboracensis	T												L	
MacGillivray's warbler	Oporonis tolmiei	W						L	L		L				
Yellowthroat	Geothlypis trichas	W									L				
Yellow-breasted chat	Icteria virens	P									L				
Wilson's warbler	Wilsonia pusilla	P									L				
American redstart	Setophaga ruticilla	T						L	L						
Painted redstart	Setophaga picta	W	L					L	L						
Worm-eating warbler	Helmitheros vermivorus	T						L	L						
Parula warbler	Parula americana	T						L	L						
Cerulean warbler	Dendroica cerulep	T						L	L						
Hooded warbler	Wilsonia citrina	T						L	L						
Weaver Finches															
House sparrow	Passer demesticus	P	L	L	L	L	L	L	L	F	L	L	L	L	

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of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Meadow Larks, Blackbirds & Orioles															
Western meadowlark	*Sturnella neglecta*	S		F	F			F				L			
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	W									L				
Red-winged blackbird	*Agelaius phoeniceus*	W										L			
Orchard Oriole	*Icterus spurius*	S						L	L			L			
Hooded oriole	*Icterus cucullatus*	S						L	L			L			
Scott's oriole	*Icterus parisorum*	S	L				F	L	L						
Bullock's Oriole	*Icterus bullockii*	S						L	L			L			
Rusty blackbird	*Euphagus carolinus*	W								L				L	
Brewer's blackbird	*Euphagus cyocephalus*	W											L	L	
Boat-tailed grackle	*Cassidix mexicanus*	S											L	L	
Brown-headed cowbird	*Molothrus ater*	W											L	L	
Tanagers															
Western tanager	*Piranga ludoviciana*	S	L					L	L						
Hepatic tanager	*Piranga flava*	S	L					L	L						
Summer tanager	*Piranga rubra*	S									L				
Grosbeaks, Finches, Sparrows & Buntings															
Cardinal	*Richmondena cardinalis*	R									L	L			
Rose-breasted grosbeak	*Pheucticus ludovicianus*	T									L	L			
Black-headed grosbeak	*Pheucticus melanocephalus*	S	L					L	L		L	L			
Blue grosbeak	*Guiraca caerulea*	S									L			L	
Indigo bunting	*Passerina cyanea*	S									L	L			
Lazuli bunting	*Passerina amoena*	W		L	L						L	L		L	
Dickcissel	*Spiza americana*	P									L	L			
Evening grosbeak	*Hesperiphona vespertina*	S	L						L	L	L	L			
Purple finch	*Carpodacus purpurpeus*	P	L							L					
Cassin's ginch	*Carpodacus cassinii*	P	L												
House finch	*Carpodacus mexicanus*	P				F	F			L	L				
Pine siskin	*Spinus pinus*	P	L					L	L						

Birds Found Along the Kaiparowits Transmission System

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
American goldfinch	Spinus tristis	P									L	L			
Lesser goldfinch	Spinus psaltria	P									L	L			
Lawrence's goldfinch	Spinus lawrencei	P							L	L					
Red crossbil	Loxia curvirostra	P	L												
Green-tailed towhee	Chlorura chlorura	P	L		L				L	L					
Rufous-sided towhee	Pipilo erythrophthalmus	P	L					F	L	F	L	L			
Brown towhee	Pipilo fuscus	P	L					F	L	F			L		
Abert's towhee	Pipilo alberti	P					L				L			L	
Lark bunting	Calamospiza melanocorys	W			L	L	L								
Savannah sparrow	Passerculus sandivichensis	P		L											
Grasshopper sparrow	Ammodramus savannarum	P		L							L	L			
Baird's sparrow	Ammodramus bairdii	T		L											
Vesper sparrow	Pooecetes gramineus	P		L	L						L	L			
Lark sparrow	Chondestes grammacus	P		L	L						L	L			
Cassin's sparrow	Aimophila cassinii	P		L											
Black-throated sparrow	Amphispiza bellineate	P			F		F								
Sage sparrow	Amphispiza belli	P		L	L	L	L	L	L	L					
Slate-colored junco	Junco hyemalis	W							L	L	L	L			
Oregon junco	Junco oreganus	W	L						L	L	L	L			
Grey-headed junco	Junco canicops	W	L						L	L	L	L			
Tree sparrow	Spizella arborea	W									L	L		L	
Chipping sparrow	Spizella passerina	W	F						L	L	L	L			
Brewer's sparrow	Spizella breweri	W									L	L			
Black-chinned sparrow	Spizella atrogularis	S			L				L	L					
Harris' sparrow	Zonotrichia querula	W	L						L	L	L	L			
White-crowned sparrow	Zonotrichia leucophrys	W							L	L	L	L			
Golden-crowned sparrow	Zonotrichia alricapilla	W							L	L	L	L			

Birds Found Along the Kaiparowits Transmission System

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies-
(by Southern California
Edison conducted
during the summer
of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
White-throated sparrow	*Zonotrichia albicollis*	W	L						L	L	L	L			
Fox sparrow	*Passerella iliaca*	W	L						L	L	L	L			
Lincoln's sparrow	*Melospiza lincolnii*	P									L	L			
Song sparrow	*Melospiza georgiana*	P									L	L			
Lapland longspur	*Calcarius lapponicus*	W		L								L			

APPENDIX II-20

Mammals Found Along the Proposed Kaiparowits Transmission System

Wildlife

Mammals found along the proposed Kaiparowits transmission system (continued)

X = Review of Literature

		Area inhabited by species					Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona, North of Colorado River	Arizona, South of Colorado River	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa Pine	Caves	Buildings	Hollow trees	Rocky Areas
Pouched Mammals																					
Virginia opossum	Didelphis marsupialis					X						X									
Insect Eaters																					
Shrews																					
Masked shrew	Sorex cinereus	X					X														
Merriam shrew	Sorex merriami	X	X	X	X			X	X												
Vagrant shrew	Sorex vagrans	X		X	X										X						
Dusky shrew	Sorex obscurus	X					X								X						
Ornate shrew	Sorex ornatus					X						X		X							
Dwarf shrew	Sorex nanus			X			X	X													
Northern water shrew	Sorex palustris		X												X						
Grey shrew	Notiosorex crawfordi		X		X	X		X	X	X	X	X	X	X							
Moles																					
California mole	Scapanus latimanus					X						X		X	X						
Bats																					
Leafnose bat	Macrotus californicus		X	X	X	X					X	X	X	X		X		X	X		
Little brown myotis	Myotis lucifugus	X		X	X		X	X					X	X	X	X		X	X	X	
Yuma myotis	Myotis yumanensis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cave Myotis	Myotis velifer					X							X					X	X		
Arizona myotis	Myotis occultus					X							X					X	X		
Long-eared myotis	Myotis evotis	X	X	X	X	X	X						X	X		X		X	X	X	
Fringed myotis	Myotis thysanodes	X	X	X	X	X							X	X		X		X	X		
California myotis	Myotis californicus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Small-footed myotis	Myotis subulatus	X	X	X	X	X							X	X		X		X	X	X	

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R	Arizona - South of Colorado R	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky Areas	Mountains
Flesh-eaters																						
Bears																						
Black bear	Ursus americanus	X		X	X	X																X
Racoons																						
Racoon	Procyon lotor	X	X	X	X	X									X							
Ringtail																						
Ringtail	Bassariscus astutus	X	X	X	X	X									X			X			X	
River Otter;																						
Weasel, badger, and skunks																						
Longtail weasel	Mustela frenata	X			X	X	X	X	X	X		X	X	X	X	X	X					
River otter;	Lutra canadensis			X	X										X							
Badger	Taxidea taxus	X	X	X	X	X		X	F	X	X	X			X							
Spotted skunk	Spilogale putorius	X	X	X	X	X		X				X	X	X	X	X					X	
Striped skunk	Mephitus mephitis	X	X	X	X	X		X	X	X	X	X	X	X	X	X						
Hognose skunk	Conepatus leucontus				X								X								X	
Dogs, Foxes																						
Coyote	Canis latrans	F	X	X	X	X	X	X	F	X	X	X	X	X	X	X	X					
Red fox	Vulpes fulva	X	X	X			X	X														
Kit fox	Vulpes macrotis	X	X	X	X	X	X				X											
Gray fox	Urocyon cineroargentus	X	X	X	X	X						X	X	X								

(continued)

Mammals found along the proposed Kaiparowits transmission system

X = Review of Literature

Bats continued

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R	Arizona - South of Colorado R	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa Pine	Caves	Buildings	Hollow trees	Rocky Areas	Mountains
Silver-haired bat	Lasionycteris noctivagans	X	X	X	X	X	X				X		X	X		X		X	X			
Western pipistrel	Pipistrellus hesperus	X	X	X	X	X	X				X	X	X	X	X	X		X	X		X	
Big brown bat	Eptesicus fuscus	X	X	X	X	X	X		X		X		X	X	X	X		X	X	X		
Red bat	Lasiurus borealis	X	X	X	X	X	X						X	X	X			X		X		
Hoary bat	Lasiurus cinereus	X	X	X	X	X	X		X			X	X	X	X							
Western yellow bat	Lasiurus ega					X	X				X											
Spotted bat	Euderma maculata	X	X	X	X	X					X							X	X			
Western big-eared bat	Plecotus townsendi	X	X	X	X	X												X	X			
Pallid bat	Antrozous pallidus	X	X	X	X	X			X			X	X	X				X	X	X	X	
Mexican freetail bat	Tadarida brasiliensis				X													X	X			
Pocketed freetail bat	Tadarida femorosacca				X	X			X		X	X	X	X				X			X	
Big freetail bat	Tadarida molossa	X	X	X	X	X			X		X	X	X	X				X	X		X	

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

Gnawing Mammals

Squirrels

		Area inhabited by Species						Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona - North of ColoradoR	Arizona - South of ColoradoR	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert desert shrub	Sonoran desert desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountains
Whitetail prairie dog	Cynomys gunnisoni	X		X	X		X	F					X									
California ground squirrel	Citellus beecheyi					X		X				X									X	
Rock squirrel	Citellus variegatus	X	X	X	X	X															X	
Townsend ground squirrel	Citellus townsendi		X					X	X													
Spotted ground squirrel	Citellus spilosoma				X		X						X									
Roundtail ground squirrel	Citellus tereticaudus		X		X	X					X	X										
Golden-mantled squirrel	Citellus lateralis	X	X	X	X	X								X			X					
Yuma antelope squirrel	Ammospermophilus harrisi				X					X	F											
Whitetail antelope squirrel Uintah	Ammospermophilus leucurus	X	X	X	X	X	X	F	F	X	F											
Least chipmunk	Eutamias minimus	X		X			X	X	X	X	X	X										X
Cliff chipmunk	Eutamias dorsalis	X	X	X	X		F			X											X	
Merriam chipmunk	Eutamias merriami					X					X											
Uinta chipmunk	Eutamias umbrinus	X		X													X					
Panamint chipmunk	Eutamias panamintinus		X			X	X				X											
Lodgepole chipmunk	Eutamias specious					X											X					
Charleston mountain chipmunk	Eutamias palmeri		X				X										X				X	
Western gray squirrel	Sciurus griseus					X											X					
Tassel-eared squirrel	Sciurus aberti			X	X												X					
Red squirrel	Tamiasciurus hudsonicus	X		X	X												X					
Northern flying squirrel	Glaucomys sabrias					X	X							X			X					

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountainous	Coastal chaparral	Interior chaparral
Pocket gophers																						
Valley pocket gopher	Thamomys bottae	X	X	X	X	X	X	X	X	X	X	X									X	X
Pocket Mice, Kangaroo Mice and Kangaroo Rats																						
Silky pocket mouse	Perognathus flavus				X		F	X	X										X			X
Apache pocket mouse	Perognathus apache				X		X	X	X													
Little pocket mouse	Perognathus longimembris	X	X	X		X	X	X	F													
Arizona pocket mouse	Perognathus amplus				X		F			X	F											
Great Basin pocket mouse	Perognathus parvus	X	X	X		X	X		X													X
Desert pocket mouse	Perognathus pencillatus		X		X	X						X										X
Rock pocket mouse	Perognathus intermedius				X						F								X			
San Diego pocket mouse	Perognathus fallax					X	X					X									X	
California pocket mouse	Perognathus californicus					X	X															
Spiny pocket mouse	Perognathus spinatus					X						X										
Longtail pocket mouse	Perognathus formosus	X	X	X		X			F		F								X			
Bailey pocket mouse	Perognathus baileyi					X													X			
Dark kangaroo mouse	Microdiposops megacephalus		X			X																
Pale kangaroo mouse	Microdiposops pallidus		X			X																
Panamint kangaroo rat	Dipodomys panamintinus		X			X	X				X											
Stephen kangaroo rat	Dipodomys stephensi					X						X										
Ord kangaroo rat	Dipodomys ordi	X	X	X	X		X	F	F													

(continued)

Mammals found along the proposed Kaiparowits transmission system

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountaineous
mice and rats, continued																						
Pacific kangaroo rat	Dipodomys agitis					X						X		X								
Desert kangaroo rat	Dipodomys deserti	X	X	X	X	X				X	X											
Merriam kangaroo rat	Dipodomys merriami	X	X	X	X	X				X	F			X								
Beaver																						
Beaver	Castor canadensis	X	X	X	X	X									X							
Mice, rats, voles, porcupine																						
Western harvest mouse	Reithrodontomys megalotis	X	X	X	X	X	X	F	X	X	X	X	X	X	X		X					
Cactus mouse	Peromyscus eremicus	X	X	X	X	X	X		F	X	F											
California mouse	Peromyscus californieus					X								X								
Canyon mouse	Peromyscus crinitus	X	X	X	X	X		F	F	X	F											
Brush mouse	Peromyscus boylei	X	X	X	X	X	X	X					X	X								
Whitefooted mouse	Peromyscus leucopus				X		X	X	X													
Pinyon mouse	Peromyscus truei	X	X	X	X	X	F	X	X												X	
Deer mouse	Peromyscus maniculatus	X	X	X	X	X	F	F	F	X	X	X	X	X	X	X	X					
Northern grasshopper mouse	Onychomys leucogaster	X	X	X	X			F	F		F		X									
Southern grasshopper mouse	Onychomys torridus	X	X	X	X	X		X	X	X	F			X								
Whitethroat woodrat	Neotoma albigula				X	X				X	F										X	
Desert woodrat	Neotoma lepida	X	X	X	X	X			F	X	F											
Stephens woodrat	Neotoma stephensi				X					X			X									
Mexican woodrat	Neotoma mexicana				X																X	

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas
Mice, rats, voles, porcupine																					
Dusky-footed woodrat	Neotoma fuscipes					X						X		X	X						
Bushytailed woodrat	Neotoma cinerea	X	X	X	X		X		X								X				
Mountain vole	Microtus montanus		X						X						X						
California vole	Microtus californicus					X						X			X						
Longtail vole	Microtus longicaudus	X		X	X	X			X						X						
Muskrat	Ondatra zibethica	X	X	X	X	X									X						
Mexican vole	Microtus Mexicanus				X			X							X		X				
House mouse	Mus musculus	X	X	X	X	X	X						X	X							
Porcupine	Erethizon dorsatum	X	X	X	X	X	X	X	X			X	X	X	X	X					
Hare and rabbits																					
Blacktail jackrabbit	Lepus californicus	X	X	X	X	X	F	X	F	X	F	X	F	X	X	X	X				
Eastern cottontail	Sylvilagus floridanus				X					X			X		X						
Mountain cottontail	Sylvilagus muttali	X	X	X			X	X	X				X		X						
Desert cottontail	Sylvilagus auduboni	X	X	X	X	X	F	F	F	X	F	F	F								
Brush rabbit	Sylvilagus bachmani					X				X	X										

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California, Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountainous
Even-Toed Herbivores																					
Peccary	Pecari angulatus				X					X			X						X		
Elk	Cervus canadensis	X					X	X	X												
Mule deer	Odocoileus hemionus	X	X	X	X	X	F	X	X		F	X	X	X	F						X
Whitetail deer	Odocoileus virginianus				X		X	X					X	X							
Pronghorn antelope	Antilocapra americana	X	X	X	X	X		X													
Bighorn sheep	Ovis canadensis	X	X	X	X	X		X												X	X
Cats																					
Mountain lion	Felis concolor	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X
Bob cat	Lynx rufus	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X

APPENDIX II - 21

Endangered, Threatened and Protected Wildlife Species Found Along the Proposed Transmission System

Wildlife

Endangered, threatened and protected wildlife species found along the proposed transmission system

Species	Location	Status[a]	Source of Status[b]
Mammals			
Spotted bat (Euderma maculata)	Rare along entire route	Threatened-US	2
Ringtail (Bassariscus astutus)	Along streams with rocks	Protected-California	4
Blackfooted ferret (Mustela nigripes)	Navaho Indian Reservation	Endangered-US	1
River otter (Lutra canadensis)	Along Colorado River	Protected-Arizona	3
Kit fox (Vulpes macrotis)	Throughout desert areas	Protected-Nevada	5
Gray squirrel (Sciurus spp.)	Ponderosa pine	Protected-Nevada	5
Red Squirrel (Tamiasciurus spp.)	Ponderosa pine	Protected-Nevada	5
Flying squirrel (Glauromys spp.)	Ponderosa pine	Protected-Nevada	5
Utah prairie dog (Cynomys parvidens)	Garfield County, Utah	Endangered-US	1
Stephen's kangaroo rat (Dipodomys stephensi)	San Jacinto, California	Rare-California	4
Porcupine (Erethiaon dorsatum)	Along entire line	Protected-Arizona	3
Bighorn sheep (Ovis canadensis)	Southern Mountains, California	Protected-California	4
Birds			
White pelican (Pelecanus ergthrorhynchos)	Along Colorado River	Protected-Nevada	5
White-faced ibis (Plegadis chihi)	Along Colorado River	Status undetermined-US	2

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
Brown Pelican (*Pelecanus occidentalis*)	Along Colorado River	Endangered-US	1
Turkey vulture (*Cathartes aura*)	Along entire route	Protected-Nevada	5
Goshawk (*Accipiter gentilis*)	Along streams and aspen groves	Protected-Nevada	5
Sharp-shinned hawk (*Accipiter striatus*)	Along streams and aspen groves	Protected-Nevada	5
Cooper's hawk (*Accipiter cooperi*)	Along streams and aspen groves	Protected-Nevada	5
Red-tailed hawk (*Buteo jamaicensis*)	Along entire route	Protected-Nevada	5
Swainson's hawk (*Buteo swainsoni*)	Along entire route	Protected-Nevada	5
Rough-legged hawk (*Buteo lagopus*)	Along entire route	Protected-Nevada	5
Ferruginous hawk (*Bureo regalis*)	Along entire route	Status undetermined-US	1
Harris' hawk (*Parrabuteo unicinctus*)	Along entire route	Protected-Nevada	5
Marsh hawk (*Circus cyaneus*)	Along meadow and wet areas	Protected-Nevada	5
Golden eagle (*Aquila chrysaetos*)	Along entire route	Protected-US	7
Northern bald eagle (*Haliaeetus leucocephalus*)	Along entire route	Protected-US	7
Southern bald eagle (*Haliaeetus leucocephalus leucocephalus*)	Southern California southern Arizona, and southern Nevada	Endangered-& Protected-US	8
Osprey (*Pandion haliaetus*)	Along Colorado River	Status undetermined	1
Prairie falcon (Falco mexicanus)	Along entire route	Threatened-US	2
Peregrine falcon (*Falco peregrinus*)	Along entire route	Endangered-US	1

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
American kestrel (Falco sparverius)	Along entire route	Protected Nevada	5
Sandhill cranes (Grus canadensis)	Along meadows Central California	Protected-California Endangered-Arizona	4 3
Mountain doves (Eupoda montana)	Central California	Endangered-Arizona	3
California yellow-billed cuckoo (Coccyzus americanus occidentalis)	California	Rare-California	4
Roadrunner (Geococcyx californianus)	Along entire route	Protected-Nevada	5
Barn owl (Tyto alba)	Along entire route	Protected-Nevada	5
Great horned owl (Bubo virginianus)	Along entire route	Protected-Nevada	5
Burrowing owl (Speoyto cunicularia)	Along entire route	Protected-Nevada	5
Long-eared owl (Asio otus)	Along entire route	Protected-Nevada	5
Short-eared owl (Asio flammeus)	Along entire route	Protected-Nevada	5
Nighthawk (Chordeiles spp.)	Along entire route	Protected-Nevada	5
Belted kingfisher (Megaceryle alcyon)	Along water	Protected-Nevada	5
Belding's savannah sparrow (Passerculus sandwichensis subsp.)	Grassland-California	Endangered-California	4
Amphibians			
Vegas Valley leopard frog (Rana pipiens fisheri)	Vegas Valley, Nevada	Threatened-US	2

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
Reptiles			
Desert tortoise (Gopherus agassizi)	Sonoran and Mohave deserts	Protected Arizona, California, Nevada	3,4,5
Gila monster (Heloderma suspectum)	Sonoran and Mohave deserts	Status undetermined - US	2
Fishes			
Virgin spinedace (Lepidomeda molliopinis)	Virgin River, Nevada	Protected-Nevada	5
Moapa dace (Moapa coriaces)	Muddy River, Nevada	Endangered-US	1
Woundfin (Plagopterus argentissimus)	Virgin & Muddy Rivers, Nevada	Endangered-US	1
Colorado River squawfish (Ptychocheilus lucius)	Colorado River	Endangered-US	1
Gila topminnow (Poeciliopsis occidentalis occidentalis)	Verde and Agua Fria Rivers, Arizona	Endangered-US	1

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[a] Definition of Status

Endangered Species: "Those species in danger of extinction throughout all or a significant portion of their range" (Source #1).

Threatened Species: "Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range" (Source #1).

Rare: A rare species is one that although not presently threatened with extinction is in such small numbers throughout its range that it may be endangered if its environment is adversely affected.

Protected: An animal which may not be taken in any way, shape, or form.

[b] Sources of Status

1. United States list of Endangered Fauna, May 1974. U.S. Department of Interior.
2. Threatened Wildlife of the United States. 1973. U.S. Department of Interior.
3. Arizona Game and Fish Laws, ARS Title 17.
4. California Department of Fish and Game Regulations, pursuant to Section 217, Fish and Game Code.
5. State of Nevada, Board of Fish and Game Commissioners, general regulation No. 1, Amendment No. 5.
6. Utah State Division of Wildlife Resources, Wildlife Resources Code of Utah.
7. Bald Eagle Act as amended.
8. 1 and 7 above.

APPENDIX II - 22

Invertebrates Found Along the Proposed Kaiparowits Transmission System

APPENDIX II-22

Wildlife

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
		HABITAT TYPES			
Centipedes	Chilopoda			F	F
Silverfish and closely related	Thysanura	F		F	
Springtails	Collembola	F	F	F	F
Grasshoppers and closely related	Orthoptera	F	F	F	F
Crickets	Gryllidae		F	F	F
Short-horned grasshoppers	Acrididae	F	F	F	F
Mantids (praying-mantid)	Mantidae	F		F	F
Walking sticks	Phasmidae	F		F	
Long-horned grasshoppers	Tettigonidae			F	
Termites	Isoptera		F		
Webspinners	Embioptera	F			
Psocids	Psocoptera	F	F	F	F
Thrips	Thysanoptera	F	F	F	F
Bugs	Hemiptera	F	F	F	F
Leaf and plant bugs	Miridae	F	F	F	F
Lace bugs	Tingidae	F	F	F	F
Assassin bugs	Reduviidae	F	F	F	F
Milkweed bugs and others	Lyaeidae	F	F	F	F
Damsel bugs	Nabidae	F		F	
Stilt bugs	Neididae	F	F	F	F
Leaf-footed bugs	Coreidae	F			
Flower and minute pirate bugs	Anthocoridae	F			

(continued)

APPENDIX II-22

Invert ' ıtes Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
		HABITAT TYPES			
Negro bugs	Corimelaenidae	F			
Stink bugs	Pentatomidae	F		F	F
Ambush bugs	Phymatidae	F			
Shield bugs	Suitelleridae	F		F	
Red bugs and stainers	Pyrrhocoridae			F	
Hoppers and closely related	Homoptera	F	F	F	F
Leaf hoppers	Cicadellidae	F	F	F	F
Aphids	Aphididae	F	F	F	F
Jumping plant lice	Psyllidae	F	F	F	F
Scale insects	Coccoidea	F	F	F	F
Froghoppers and spittlebugs	Crcopidae	F	F	F	F
Fulgorid planthoppers	Fulgoroidea	F		F	F
Phylloxerans	Phylloxeridae	F		F	
Treehoppers	Membracidae	F		F	
Whiteflies	Aleyrodidae	F		F	F
Cicadas	Cicadidae			F	
Antlions and closely related	Neuroptera	F	F	F	F
Raphidiid snakeflies	Rhophididae		F		
Dusty-wings	Conoipterygidae	F		F	F
Brown lacewings	Hemorolidae	F		F	
Antlions	Myrmeleontidae	F		F	F
Green lacewings	Chrysopidae	F		F	F
Beetles	Coleoptera	F	F	F	F
Soft-winged flower beetles	Melyridae	F	F	F	F

(continued)

APPENDIX II-22

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Rove beetles	Staphylinidae	F	F	F	F
Leaf beetles and others	Chrysomelidae	F	F	F	F
Snout beetles	Curculionidae	F	F	F	F
Silken fungus beetles	Crystophagidae	F	F	F	F
Pedilid beetles	Anthicidae	F	F		
Powder-post beetles	Lyctidae	F	F		
Skin beetles and others	Dermestidae		F		
Blister beetles	Meloidae		F		
Click beetles	Clasteridae	F		F	F
Metallic wood-boring beetles	Buprestidae	F			
Drugstore and death-watch beetles	Anobiidae	F			
Ladybugs	Coccinellidae	F			F
Minute brown scavenger beetles	Lathridiidae	F	F	F	F
Darkling beetles	Tenebrionidae		F		
Ground beetles	Carabidae	F	F	F	
Seed beetles and others	Bruchidae	F	F	F	F
Antlike flower beetles	Anthicidae	F		F	
June beetles and others	Scarabaeidae	F		F	
Predaceous diving beetles	Dytiscidae	F			
Shining flower beetles	Phalacridae	F			
Checkered beetles and others	Cloridae	F		F	F
Hister beetles	Historidae	F		F	
False darkling beetles	Melandryidae	F		F	
Round fungus beetles	Leiodidae	F	F	F	

(continued)

APPENDIX II-22

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Tumbling flower beetles	Mordellidae	F			F
Long-horned wood-boring beetles	Ceramdycidae	F		F	
Short-winged mold beetles	Pselaphidae			F	
Sap beetles	Nitidulidae			F	F
Caddisflies	Trichoptera	F	F	F	
Butterflies and moths	Lepidoptera	F	F	F	F
True flies	Diptera	F	F	F	F
Robber flies	Gsilidae	F	F	F	
Rootgnats	Sciaridae	F	F	F	F
Gallignats	Cecidomyudae	F	F	F	F
Long-legged flies	Dolichopodidae		F		
Tachinid flies	Tachinidae	F	F	F	F
Small fruit flies	Drosophilidae	F	F	F	F
Anthomyiid flies	Anthomyiidae		F	F	F
Humpbacked flies	Phoridae	F	F	F	
Shore flies	Ephydridae		F		
Black scavenger flies	Sepsidae	F		F	
Frit and stem flies	Chloropidae	F		F	
House and stable fly and others	Muscidae	F		F	
Midges	Chironomidae	F			
Trixoscelid flies	Trixoscelidae	F			
Minute black scavenger flies	Scatopsidae	F		F	
Biting midges	Ceratopagonidae	F		F	F
Mosquitos	Cylicidae	F			
Bee flies	Bombylidae	F		F	F
Big-headed flies	Pipuniulidae	F		F	

(continued)

APPENDIX II-22

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Flower flies	Syrpidae	F		F	
Lauxaniid flies	Lauxaniidae	F		F	
Dance flies	Empididae	F		F	F
Fruit flies	Tephritidae	F		F	F
Flesh flies	Sarcophagidae	F		F	
Stiletto flies	Therevidae	F		F	
Fungus gnats	Myscetophilidae			F	
Blow flies	Calliphoridae			F	
Leaf-miner flies	Agomyzidae			F	
Picture-winged flies	Otitidae			F	
Helcomyzid flies	Helcomyzidae			F	
Ants, bees, and closely related	Hymenoptera	F	F	F	F
Braconids	Braconidae	F	F	F	F
Chalcids	Chalcidordea	F	F	F	F
Gall wasps and others	Cynysoidea	F	F	F	F
Velvet ants	Mutillidae		F	F	
Ants	Formicidae	F	F	F	F
Ichneumons	Ichneumonidae	F	F	F	
Parasitic Hymenoptera	Proctotrupoidea	F	F	F	F
Parasitic Hymenoptera	Bethyloidea	F		F	F
Sphecoid wasps	Sphecoidea	F		F	
Vespoid wasps	Vespoidea	F			
Chalcids	Chalkidoidea	F		F	
Parasitic wasps and ants	Scoloidea	F			
Bees	Apoidea	F		F	

(continued)

APPENDIX II-22

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Scorpions	Scorpionida			F	
Mites and ticks	Arcarina	F	F	F	F
Spiders	Araneida	F	F	F	F
Solpugids	Solpugida		F	F	

APPENDIX II - 23

Reptiles and Amphibians Found Along the Proposed Kaiparowits Transmission System

APPENDIX II - 23

Wildlife

Reptiles and Amphibians Found Along the Proposed Kaiparowits Transmission System

Basis for Listing: F = Recent Field Studies

L = Review of Literature

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Amphibians											
Salamanders											
Tiger salamander	Ambystoma tigrinum	L						L		L	
California newt	Taricha toroso	L									L
Ensatina	Ensatina eschecholtzi	L				L					L
Pacific slender salamander	Batrachoseps pacificus		L				L				L
California slender salamander	Batrachoseps attenuatus		L				L				L
Toads											
Western spadefoot toad	Scaphiopus hammondi	L								L	L
Great Basin spadefoot toad	Scaphiopus intermountanus					L		L	L	L	

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Toads continued											
Western toad	Bufo boreas	L			L	L					L
Woodhouse's toad	Bufo woodhousei	L		L	L			L	L	L	
Southwestern toad	Bufo microscaphus	L						L	L	L	L
Red-spotted toad	Bufo punctatus	L			L			L	L	L	L
Great Plains toad	Bufo cognatus	L		L				L	L	L	L
Frogs											
Chorus frog	Pseudacris triseriata	L								L	
Canyon treefrog	Hyla arenicolor	L						L		L	
Pacific treefrog	Hyla regilla	L							L	L	L
Red-legged frog	Rana aurora	L									L
Leopard frog	Rana pipiens	L						L	L	L	L
Vegas Valley leopard frog	Rana pipiens fisheri	L							L		

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Frogs continued											
Bullfrog	*Rana catesbeiana*							L	L	L	L
Reptiles											
Desert tortoise	*Gopherus agassizi*			F				L	L	L	F
Lizards											
Banded gecko	*Coleonyx variegatus*	L	L	F		L	L	L	L	L	F
Desert iguana	*Dipsosaurus dorsalis*		L	F				L	L	F	L
Chuckwalla	*Sauromalus obesus*	L	L	L				L	L	L	L
Lesser earless lizard	*Holbrookia maculata*			L	F			L		F	
Zebra-tailed lizard	*Callisaurus draconoides*		L	F				L	F	F	F
Coachella valley fringe-toed lizard	*Uma inornata*			L							L
Mojave fringe-toed lizard	*Uma scoparia*			L							L
Collard lizard	*Crotaphytus collaris*		L	F				F	L	F	L
Leopard lizard	*Crotaphytus wislizeni*	L		F	L			L	L	F	F

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Lizards continued											
Desert spiny lizard	*Sceloporus magister*	L		F		F	L	L	L	F	L
Granite spiny lizard	*Sceloporus orcutti*		L	L			L				L
Western fence lizard	*Sceloporus occidentalis*	L	L				F	L	L		F
Eastern fence lizard	*Sceloporus undulatus*	L	L					L		L	
Sagebrush lizard	*Sceloporus graciosus*	L	L	L	L	L	L	L	L	L	
Side-blotched uta	*Uta stansburiana*		L	F	L	F	L	F	L	F	F
Long-tailed brush lizard	*Urosaurus grociosus*			L					L	L	L
Coast horned lizard	*Phrynosoma coronatum*	L				L	F				F
Desert horned lizard	*Phrynosoma platyrhinos*			F				L	F	F	F
Short-horned lizard	*Phrynosoma douglassii*		L	L				L		L	
Flat-tailed horned lizard	*Phrynosoma m'calli*		L	L							L

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Lizards continued											
Granite night lizard	Xantusia henshawi	L	L								L
Desert night lizard	Xantusia vigilis	L				L		L	L	L	L
Western skink	Eumeces skiltonianus	L	L		L	L	L	L	L		L
Gilbert's skink	Eumeces gilberti	L	L		L	L	L		L		L
Orange-throated whiptail	Cnemidophorus hyperythrus		L	L							L
Plateau whiptail	Cnemidophorus velax	L	L	L				L	L		
Western whiptail	Cnemidophorus tigris	L	L	F		L	L	F	L	F	F
Southern alligator lizard	Gerrhonotus multicarinatus				L		L				L
Gila monster	Heloderma suspectum		L	L				L	L	L	L
Snakes											
Western blind snake	Leptotyphlops humilis	L	L					L	L	L	L
Rosy boa	Lichanura trivirgata	L	L	L			L			L	L

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Ringneck	Diadophis punctatus	L			L	L	L	L	L	L	L
Spotted leaf-nosed snake	Phyllorhynchus decurtatus			F					L	L	F
Racer	Coluber constrictor	L			L			L	L	L	L
Coachwhip	Masticophis flagellum	L			L	L		L	L	L	L
Striped racer	Masticophis lateralis	L		F			L				F
Striped whipsnake	Masticophis taeniatus	L		L		L	L	L	L	L	L
Western patch-nosed snake	Salvadora hexalepis	L	L	L			L	L	L	L	L
Glossy snake	Arizona elegans	L	L	L	L	L	L	L	L	L	L
Gopher snake	Pituophis melanoleucus	L	L	L	L	L	L	L	L	L	L
Common kingsnake	Lampropeltis getulas	L		L	L		L	L	L	L	L
California mountain kingsnake	Lampropeltis zonata					L	L				L

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Long-nosed snake	Rhinochailus lecontei			L	L			L	L	L	L
Western garter	Thamnophis elegans	L	L	L		L		L		L	
Western aquatic garter snake	Thamnophis couchi	L									L
Black-necked garter snake	Thamnophis crystops			L		L	L			L	
Western ground snake	Sonora semianulata		L	L				L	L	L	L
Western shovel-nosed snake	Chionactis occipitalis		L	L					L	L	L
Western black-headed snake	Tantilla planiceps		L	L		L	L	L	L	L	L
California lyre snake	Trimorphodon vanderburghi		L	L							L
Sonora lyre snake	Trimorphodon lambda		L	L	L	L		L	L	L	L
Night snake	Hypsiglena torquata		L	L	L	L	L	L	L	L	L
Western diamond back rattle-snake	Crotalus atrox	L	L	L	L	L				L	L

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Red diamond rattlesnake	Crotalus ruber	L	L	L	L						L
Speckled rattlesnake	Crotalus mitchelli	L	L	L	L			L	L	L	L
Sidewinder	Crotalus cerastes	L	L	L	L			L	L	L	L
Western rattlesnake	Crotalus viridus	L	L	L	L			L	L	L	L
Mohave rattlesnake	Crotalus scutulatus	L	L	L	L			L	L	L	L

APPENDIX II - 24

Fishes Found Along the Proposed Kaiparowits Transmission System

APPENDIX II- 24

Wildlife

Fishes Found Along The Proposed Kaiparowits Transmission System

		Species Location					
		Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Herring and Shad							
Treadfin shad	Dorosoma petensense atchafalayae					L	L
Salmon and Trout							
Coho salmon	Oncorhynchus kisutch					L	L
Kokanee salmon	Oncorhynchus nerka					L	L
Rainbow trout	Salmo gairdneri	L				L	L
Brown trout	Salmo trutta					L	L
Carps and Minnows							
Long fin dace	Agosia chrysogaster	L	L				
Goldfish	Carassius auratus						L
Carp	Cyprinus carpio					L	L
Roundtail chub	Gila robusta			L	L	L	L
Swiftwater - Roundtail chub	Gila robusta elegans			L		L	L
Virginia spinedace	Lepidomeda mollispinis			L			
Moapa dace	Moapa coriacea				L		

Fishes found along the proposed Kaiparowits transmission system
(continued)

		Species Location					
		Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Golden shiner	*Notemigonus crysoleucas*					L	L
Red shiner	*Notropis lutrensis*					L	L
Fathead minnow	*Pimephales promelas*	L				L	L
Woundfin	*Plagopterus argentissimus*			L			
Speckled dace	*Rhinichthys osculus*					L	L
Suckers							
Sonora sucker	*Catostomus insignis*		L				
Mountain sucker	*Catostomus platyrhynchus*		L	L	L	L	L
Humpback sucker	*Xyrauchen texanus*			L	L	L	L
Catfishes							
Black bullhead	*Ictalurus melas*					L	L
Yellow bullhead	*Ictalurus natalis*	L				L	L
Channel catfish	*Ictalurus punctatus*	L				L	L
Smallmouth bass	*Micropterus dolomieui*	L					
Livebearers							
Mosquito fish	*Gambusia affinis*	L		L	L	L	L
Shortfin molly	*Poecilia mexicana*				L	L	L

Fishes found along the proposed Kaiparowits transmission system (continued)

		Species Location					
		Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	L	L				
Sunfishes							
Green sunfish	*Lepomis cyanellus*					L	L
Bluegill	*Lepomis macrochirus*					L	L
Largemouth bass	*Micropterus salmoides*					L	L
Black crappie	*Pomoxis nigromaculatus*					L	L
Perches							
Walleye	*Platyrhynchus vitreum vitreum*					L	L

APPENDIX II - 25

Archaeological Site Descriptions

Paleontological, Archaeological, and Historical

Kaiparowits Plateau impact area

Archaeological site descriptions

Lithic Scatter Sites: Thirteen sites exhibit lithic materials which include debitage, chipped and ground stone implements, and projectile points. Six sites display debitage associated with projectile points only. Absence of ground stone on these sites suggests that hunting was predominant. Seventeeen sites consisted only of debitage and unfacially flaked stone tools. Most materials are waste flakes, though some show signs of casual utilization. These sites, it would seem, were largely centers for the manufacture of stone tools which were subsequently carried elsewhere for use.

Ceramic Scatter Sites: One site, a sherd scatter, has been recorded outside the proposed plant site and one half mile radius boundaries in an area of anticipated immediate impact (so designated by virtue of the anticipated further development of the Fourmile Bench aircraft landing strip).

Lithic Ceramic Scatter Sites: Two sites, recorded on the proposed plant site, exhibited associations of pottery with a scatter of lithic material and contained no surface indications of hearth.

Lithic Campsites: Three such sites were recorded on the proposed plant site. Two more sites were recorded outside the proposed plant site boundary. This type of site exhibits surface indications of hearths in association with a scatter of lithic material.

The presence of hearths on these sites would tend to support the idea of their use as temporary habitations, especially where architectural features were noted.

Rockshelter/Habitation Sites: Cultural deposits were not found in any rockshelters on the proposed plant site. One site, 100 yards in diameter, showing heavy concentrations of exposed cultural deposits and inferrentially buried continuous deposits of lithic debitage, sherds, and stone tools, and possible architectural units, perhaps including domestic houses was recorded. This site represents the most significant single archaeological resource located in the Fourmile Bench locality. Based on present knowledge, this site is of major significance considering all other remains located and studied to date.

Masonry Sites: One such site was identified on the proposed plant site. It consists of a one-unit structure, probably utilized for storage. The fact that the site is inaccessible without special equipment precluded any investigation of its contents.

No historic sites dating prior to 1950 were found on the plant site or adjacent area.

Coal mine site and adjacent area

Lithic Scatter Sites: Eighteen sites were recorded within the proposed coal mine area. Two additional sites were in adjacent sections. Of these, nineteen were characterized by the presence of only flaked stone tools. One site displayed an association of ground stone with flaked stone artifacts.

Lithic/Ceramic Scatter Sites: One site of this class was in an area adjacent to the proposed coal mine site. It was characterized by an association of debitage with a limited number of sherds, apparently from a single vessel.

Lithic Campsites: Five campsites of this nature are in the proposed coal mine area. Two have hearths associated with ground and flaked stone tools. The remaining sites have hearths and flaked stone tools only.

Rockshelter Sites: Two rockshelter complexes with associated cultural material were present in the proposed coal mine site. An additional shelter with cultural material was found in an adjacent section.

Historic Sites: An historic site consisting of a tent foundation and associated juniper and brush corrals is located within the proposed coal mine site.

Artifacts associated with this site suggest it to be a product of modern sheep herding activity.

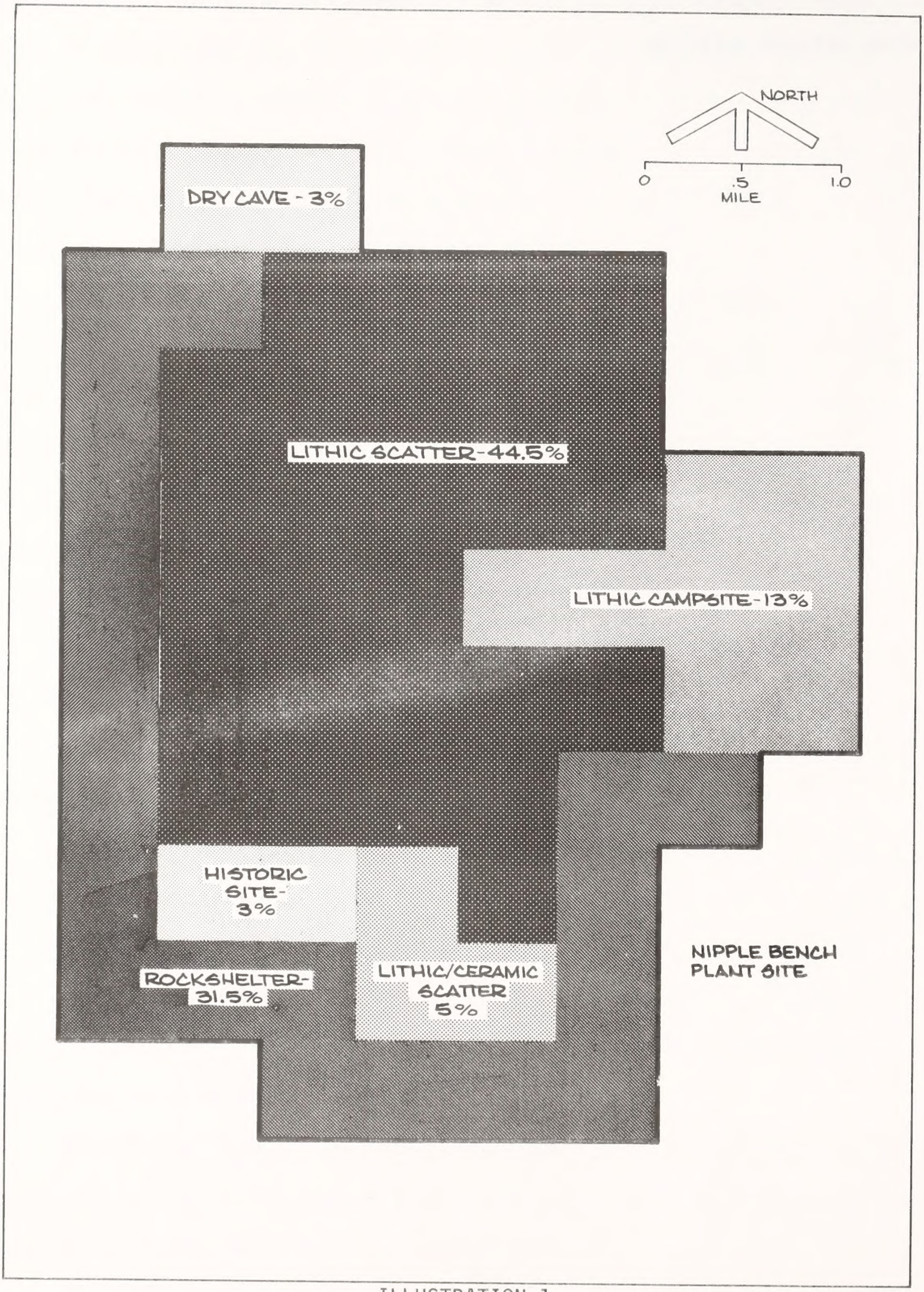

ILLUSTRATION 1

Percentage Distribution of Archaeological Site Types on Proposed Nipple Bench Plant Site

APPENDIX II - 26

Archaeological Site Photographs

Transmission System, Mohave to Serrano Route

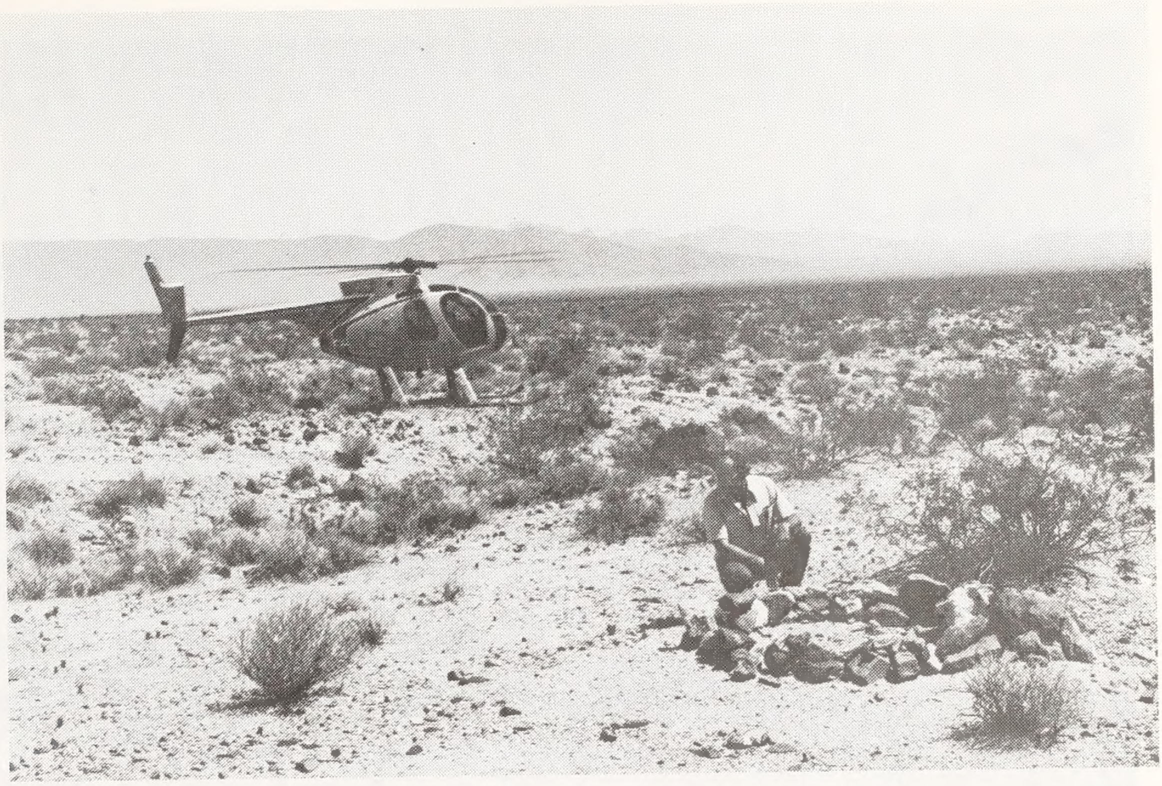

ILLUSTRATION 1

Structure ring, archaeological site K-1, Little Paiute Mountains, California

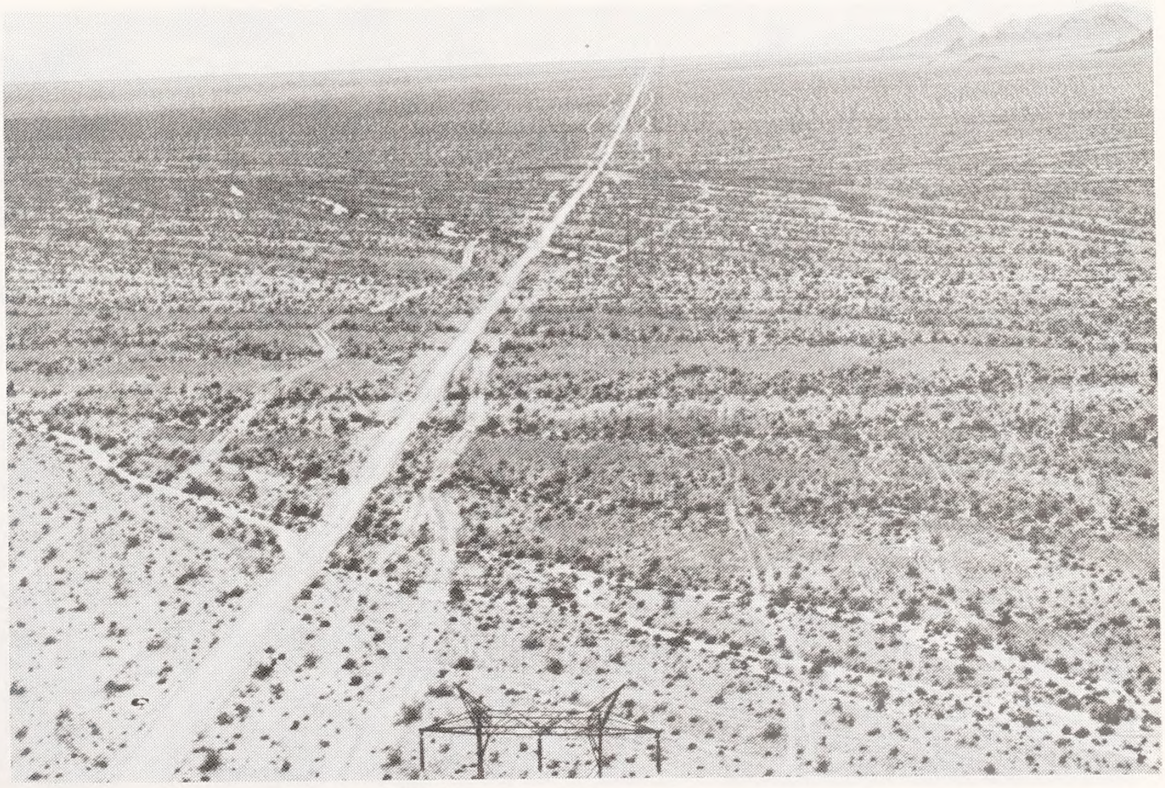

ILLUSTRATION 2

Aerial view of archaeological site K-1 Little Paiute Mountains-Ward Valley, California, showing old fan remnants

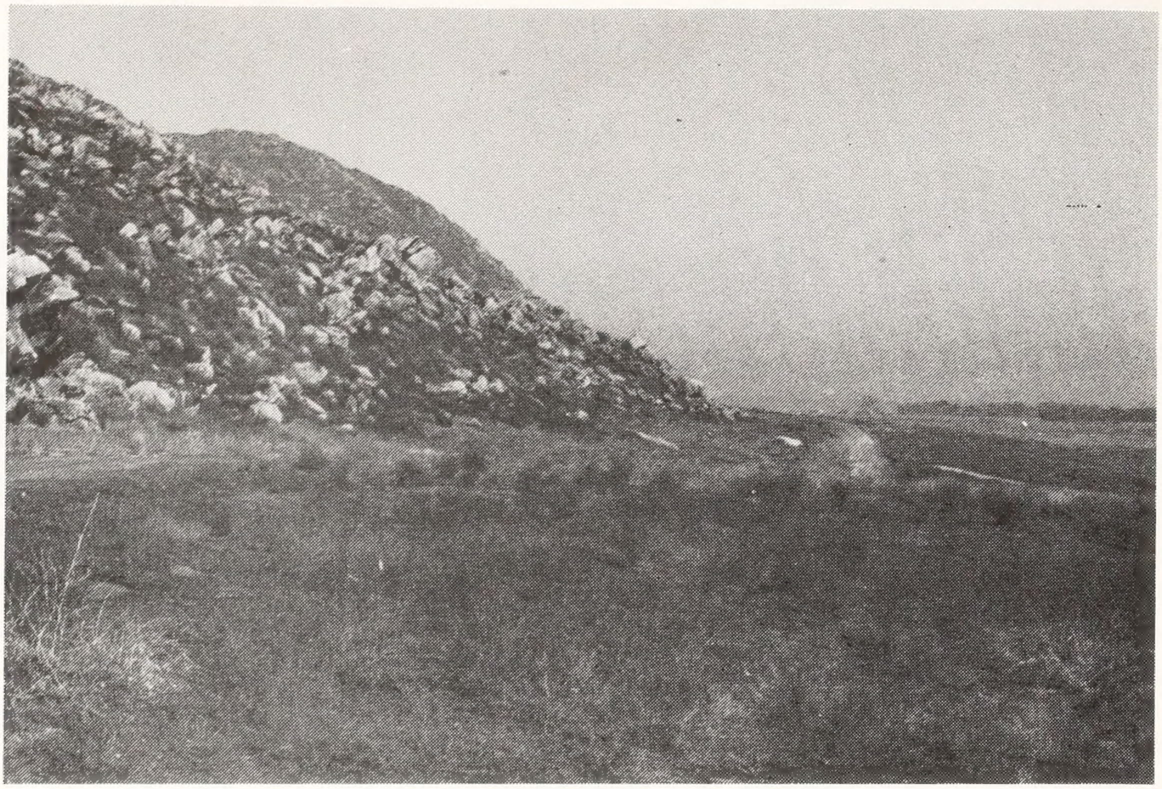

ILLUSTRATION 3

General view northwest of archaeological site
CA-Riv-399, San Jacinto Valley, California

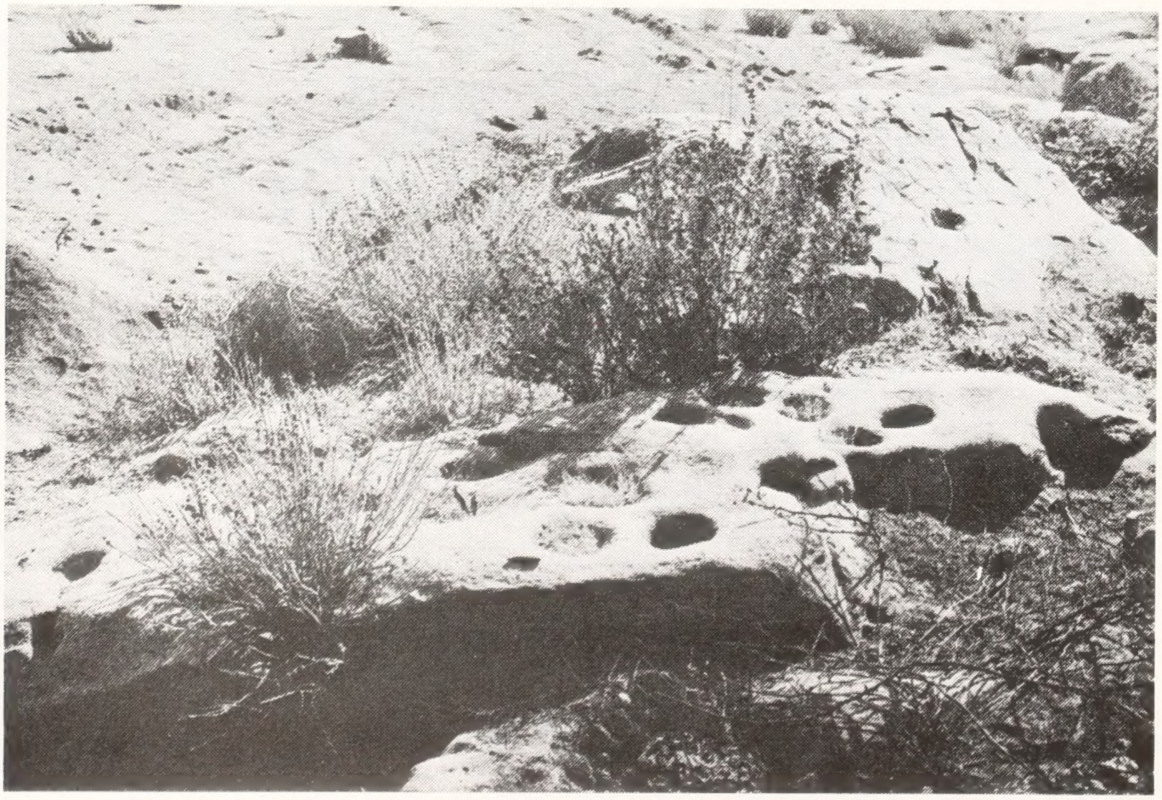

ILLUSTRATION 4

Bedrock mortar feature at CA-Riv-399
San Jacinto Valley, California

APPENDIX III-1

Air Quality

Position of Utah Air Conservation Committee on Proposed Emission Controls for the Kaiparowits Power Plant

1896

CALVIN L. RAMPTON
Governor

PAUL S. ROSE
Executive Director

STATE OF UTAH–DEPARTMENT OF SOCIAL SERVICES

DIVISION OF HEALTH
44 MEDICAL DRIVE
SALT LAKE CITY, UTAH 84113
AREA CODE 801

Board of Health
Air Conservation Committee
Health Facilities Council
Medical Examiner Committee
Nursing Home Advisory Council
Water Pollution Committee

MAN J. OLSEN, M.D., M.P.H.
Director of Health

533-6108

BUREAU OF ENVIRONMENTAL HEALTH
72 East 4th South
Salt Lake City, Utah

December 1, 1975

Mr. Paul L. Howard
State Director
United States Department of the Interior
Bureau of Land Management
Utah State Office
P. O. Box 11505
Salt Lake City, Utah 84147

Dear Mr. Howard:

The following information is in answer to your letter of November 24, 1975, concerning emissions control from the proposed Kaiparowits plant:

1. On November 18, 1974, concept approval was granted for the construction of the Kaiparowits plant. Concept approval for any proposal may be granted only if our review of the data submitted plus other information available to us indicate that technology is available to control emissions from the proposed installation sufficiently to meet all State requirements. Following this, each stage of construction that presents a potential air pollution source or which contains air pollution control equipment must be individually reviewed and approved to insure that the control technology the company elects to use will indeed result in meeting our requirements.

The Kaiparowits' proposal received concept approval on the basis of submitted specifications which included controls: 99.5% for particulate, 90% for SO_x and 30% for NO_2.

At the present time, to the best of our knowledge, these represent the maximum controls technically feasible, thus would meet the State Air Quality Regulation 1.3. (As a matter of fact, we are not convinced that the presently available technology will reliably achieve 90% removal of SO_x from power plant stack gases; however, we anticipate that the technology will be sufficiently improved to do so by the time it is needed for Kaiparowits.)

If more effective technology has been developed by the time of installation, and it is deemed feasible and reasonable, more stringent controls could be required.

2. The regulations provide for equipment failure or malfunction. In both Sections 2.2.6(b) (Visible Emissions) and 2.5.3 (Emissions of Sulfur Compounds), reporting procedures are specified and the decision as to occurrence of a violation will be made on each incident. Companies submitting reports of such incidents considered unacceptable are subject to penalites provided in the law, and/or an order to curtail or cease operations until the situation is rectified.

3. Under any circumstances (including equipment failure or malfunction), if the probability develops of exceeding either the ambient air standards or the applicable episode action level (Section 3.1), the company is subject to an order to curtail operations to prevent these values from being exceeded.

Sincerely,

Grant S. Winn, Ph.D.
Executive Secretary
Utah Air Conservation Committee

GSW:bw

APPENDIX III-2

Air Quality

Field Tracer Plume Simulation Study

APPENDIX III - 2

Air Quality

Kaiparowits Plateau impact area

Field tracer plume simulation study

Oil fog simulation trials were conducted at five potential sites between November 9 and 17, 1973 (Spangler et al. 1973). Sites included Fourmile Bench (6,100 feet MSL), Horse Flat (5,900 feet MSL), Dry Bench (5,200 feet MSL), John Henry Bench (5,000 feet MSL), and Nipple Bench (5,200 feet MSL). Meteorological observations consisted of vertical temperature soundings from aircraft, vertical wind profiles (pibals) for each site at four hour intervals between 0300 and 1900 MST, and simultaneous pibals at the Page airport.

Smoke releases were made at dawn, mid-morning, and early afternoon over the site at calculated effective stack height.

Three smoke release days were under neutral to moderately stable conditions (TVA criteria). One smoke release day was under stable conditions. During the stable condition release, the plume was observed to move in a straight line toward the northeast with little vertical movement, and was visible for 20 miles downwind. The Fourmile Bench plume followed the terrain up and over the Kaiparowits Plateau and then descended into the valley north of the plateau where it rapidly dispersed. Ten smoke releases were made over Fourmile Bench and twenty releases were made during the entire study.

During May 1974, studies were conducted including oil fog-FP tracer releases (Spangler et al., 1974). Ten tracer releases were made, seven at Fourmile Bench and three at Nipple Bench. Oil fog was released simultaneously with the FP tracer releases at calculated effective stack height for quantitive dispersion evaluations and air-mass flow visualization. Turbulence data were gathered on one Fourmile Bench flight and three Nipple Bench flights. At the beginning of each flight, a vertical temperature and turbulence sounding was usually taken. All tracer releases at Fourmile Bench were made during neutral (Category D) stability conditions.

The November studies indicated that atmospheric turbulence intensities varied from light to moderate. Generally, lowest turbulence values were found during early morning hours, increasing in intensity during the day. Comparison with other sites in the area strongly suggested that turbulence levels at plume altitude were consistently stronger over Fourmile Bench than over the other locations.

For air mass stability conditions classified as neutral (Pasquill D) over flat terrain, the observed dispersion characteristics at Fourmile Bench varied between those expected for slightly unstable (Pasquill C) to very unstable (Pasquill A) atmospheric conditions. For a slightly stable air mass (Pasquill E), the observed dispersion characteristics were close to slightly unstable (Pasquill C).

Visual and quantitative measurements of smoke tracer plumes indicated that stack effluents emitted from the Fourmile Bench site should not encounter adverse dispersion effects while being transported to the north and northeast.

Terrain induced turbulence will result in significantly faster dilution of stack effluents than was predicted with standard dispersion parameters applicable for flat terrain.

Fluorescent particle tracer impact, when equated to equivalent hourly or three-hour SO_2 concentrations, was less than 0.02 ppm SO_2 for slightly stable and most neutral and looping plume conditions. During one of the tracer releases, the maximum one-hour equivalent SO_2 concentration was less than 0.02 ppm from a looping plume condition. Maximum SO_2 concentration was less than 0.03 ppm under slightly stable, coning and looping plume conditions.

Visual tracking of oil fog plume confirmed the general areas of potential impact indicated by FP tracer patterns.

Aerial plume measurements made under predominately neutral conditions showed that relative plume centerline values were consistent or lower than values predicted with the Gaussian Plume Model.

Analysis of wind measurements taken simultaneously at the Page airport and Fourmile Bench showed a relatively good correlation between the two at expected plume altitude, with the best correlation occuring during afternoon hours. Recognizing certain constraints such as low pressure systems, low-level drainage winds at Page, passage of fronts, etc., Page Airport pibal winds could be used to typify plume transport over Fourmile Bench.

APPENDIX III-3

Air Quality

Model Simulation of Potential Air Quality Impact of the Kaiparowits Power Generating Station

APPENDIX III-3

Air Quality

Model Simulation of Potential Air Quality Impact of the Kaiparowits Power Generating Station

This appendix contains a study by Intera Environmental Consultants Ltd. to compare the Intera atmospheric diffusion model (Intercomp) with results obtained using other diffusion models.

This study includes results of model comparison with plume tracer studies (using fluorescent particle tracers) and model simulation of potential air quality impacts of the Kaiparowits power generating station.

MODEL SIMULATION OF
POTENTIAL AIR QUALITY IMPACT
OF THE KAIPAROWITS POWER GENERATING STATION

Prepared for

Southern California Edison Company

by

Gale F. Hoffnagle, Senior Environmentalist
INTERA Environmental Consultants, Ltd.

July, 1974

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SUMMARY AND CONCLUSIONS

PROBLEM:

Will the operation of the proposed Kaiparowits power plant result in groundlevel sulfur dioxide concentrations in excess of the federal ambient air quality standards?

RECOMMENDATIONS:

1. Site generating capacity up to 12000 MW will not seriously endanger attainment or maintenance of the federal ambient air quality standards for sulfur dioxide.

2. No significant difference in terms of expected air quality was found between the Fourmile Bench and Nipple Bench proposed sites.

BASES:

1. Predictions using the INTERA model of maximum groundlevel concentrations for "worst case" meteorological conditions show that up to 12000 MW site capacity does not even approach the federal ambient air quality standards. Greater capacity, perhaps twice that capacity, could be added without danger of exceeding ambient air quality standards. Prior to extrapolating predictions beyond 12000 MW more meteorological data and perhaps monitored data at an operating power plant should be available.

2. The INTERA model was validated for the available tracer data obtained at the Kaiparowits site. It proved slightly more accurate in simulating the tracer data than several Gaussian based models tested in unstable and neutral situations. The simulations indicate, as did on-site turbulence measurements, that the proposed power plant locations are subject to greater dispersive power than the normal measures of stability class would indicate.

3. "Worst" case concentrations occur quite close to the plant sites and the size of the Bench at each site is more important than its elevation. The Nipple Bench site with higher stacks and a smaller Bench results in slightly lower concentrations than from th Fourmile Bench site.

MODEL SIMULATION OF THE POTENTIAL
AIR QUALITY IMPACT OF THE
KAIPAROWITS POWER GENERATING STATION

1.0 INTRODUCTION

A diffusion model evaluation has been performed of the potential air quality impact of two proposed sites for the Kaiparowits Power Generating Station. Several different air pollutant dispersion model approaches have been tested against the fluorescent particle tracer data obtained by North American Weather Consultants in May, 1974[1]. These models were: (1) the Gaussian model and assumptions used in the Southwest Energy Study by NOAA personnel, (2) the "valley model" under the name of C4M3D developed by the Environmental Protection Agency, (3) the models developed by the Tennessee Valley Authority, and (4) the numerical model of INTERA. Ability of these models to simulate the field experiment results was utilized as a criteria for the selection of a model for use in impact predictions.

The meteorology during the field experiments unfortunately did not include all the atmospheric conditions which are generally regarded as producing higher groundlevel pollutant concentrations. An adequate assessment of the potential impact of the power station requires that these more serious atmospheric situations be investigated utilizing modeling techniques. The prediction phase of this modeling study included stable, unstable, limited mixing, and inversion breakup atmospheric conditions. The available knowledge of the meteorological characteristics of the two potential sites was utilized as a guide to these predictions.

The predictions were then extrapolated from the initial power plant load of 3000 mw to a 12000 mw capacity. An evaluation was made of whether this further capacity could be added at each site without some probability of exceeding the federal ambient air quality standards.

2.0 AIR QUALITY MODELS TESTED

The following sections describe the models tested in this evaluation. These sections will provide the basic assumptions used in each model since the above nomenclature for the models is not totally descriptive.

2.1 The NOAA Model

The Gaussian calculational technique utilizes the various Pasquill atmospheric stability classes. In flat terrain situations, the model is used in the classical way described in Turners' workbook[2]. Where terrain is important, however, NOAA has developed additional assumptions for use in the Southwest Energy Study[3]. For completeness, we have summarized all the important assumptions made about this model.

These assumptions can be listed as:

(1) A mean wind is used to represent the entire air layer important in atmospheric diffusion.

(2) A single mean wind direction specifies the x-axis.

(3) The plume concentrations are assumed normally distributed (Gaussian) in the cross-wind and vertical directions.

(4) The standard deviations, σ_y and σ_z, are representative of averaging times in the range of 10 minutes to one hour.

(5) The source emission rate as well as wind and atmospheric conditions must be constant over times significantly greater than the travel time to a downwind position of interest.

The above assumptions describe those necessary in the flat terrain case. For rough, mountainous terrain additional restrictions were imposed by NOAA:

(6) Under neutral or unstable atmospheric conditions, the plume centerline is assumed to flow parallel to the terrain.

(7) Under stable conditions, the plume centerline flows horizontally until it encounters terrain at the plume elevation. The plume centerline is assumed to impact directly on the terrain.

Some discussion of these last two points may be in order. Under neutral conditions, there is little density effect inhibiting vertical flow. Thus, an obstacle in the flow path will cause substantial modification of the flow field both horizontally and vertically. For stable conditions, the density decreases drastically with height. In this case as air encounters an obstacle, there is more of a tendency to flow horizontally around the obstacle than up and over it.

The concept expressed by assumption (7) above is that under stable conditions vertical flow is inhibited. Carrying this to its limit, the assumption is made that the plume must flow horizontally until it encounters the terrain. The concept in (6) is that for neutral and unstable flows there is no retarding influence to vertical flow.

This assumption contained in (7) is, of course, conservative in terms of significantly overestimating groundlevel concentrations. Whereas (6) could result in lower groundlevel concentrations than actual.

2.2 The EPA Model (C4M3D)

The EPA model (the version tested is known as C4M3D) is a modified version of the NOAA concepts in the method by which terrain effects are incorporated. Basically, there are two modifications which are listed below as a continuation of the set of Gaussian assumptions.

(8) The plume centerline does not intersect the terrain, but after approaching within 10 m vertical distance it remains that distance above the ground surface.

(9) Angular segment averaging of the plume concentrations is done for short-term averages as well as for annual averages.

As discussed previously, a stable atmosphere restricts vertical flow. The concept of allowing the plume to remain 10 m above the terrain is an attempt to remove some of the conservatism contained in a centerline intersection assumption.

In item (9) the averaging is generally performed over a 22.5 degree angular segment. This results in concentrations which are reduced over the customary Gaussian model. This reduction depends upon downwind distance and upon atmospheric stability. The reduction in centerline concentrations is simply $\sigma y/0.157x$ where σy is the crosswind standard deviation and x is the downwind distance from the source. For F stability, the reduction varies between 4 and 8 over the distance range of 100 m to 100 km. For C stability the reduction varies between 1.25 and 2.6 over the same distance range.

The concept behind this angular segment averaging is that for a given wind direction, the mean wind direction is actually distributed uniformly throughout the entire 22.5 degree angular segment over the period of time of interest. For longer term averages, annual, seasonal, or monthly, the assumption is probably valid. For short-term averages, 3 hours or less, it is more questionable.

2.3 TVA Model

The Tennessee Valley Authority has developed a set of essentially Gaussian calculational techniques [4]. They are specific for three important meteorological situations; namely, coning, trapping (referred to here as limited mixing) and inversion breakup. These conditions are normally associated with the highest groundlevel concentrations. The assumptions utilized are essentially (1) through (5) listed under the NOAA model. The standard deviations, σ_y and σ_z, are, however, of TVA's own derivation. The coning model is the only one utilized in this model comparison study because of the meteorological conditions in the field study. Details of the limited mixing and inversion breakup models are, therefore, not presented here. Use of the TVA coning model by Southern California Edison has previously included assumption (7) for neutral and unstable atmospheric situations and this modification has been included here for ready comparison.

It must be remembered that the coning model is inflexible to the extent that it represents neutral stability only and does not have a range of stability classes, i.e. unstable, with which to attempt simulation of field experiments.

2.4 Crosswind Concentrations

The three essentially Gaussian approaches utilized in this study were designed primarily for predictions. In predictive model uses, only the plume centerline values are considered since crosswind (y direction) values are less than the centerline. Lack of consideration for crosswind concentration receptors makes these models difficult to evaluate in a simulation situation. In the cases of the NOAA model and TVA coning model it appears that the standard crosswind correction factor based on a Gaussian distribution (see reference 2) can be added without harming the basic model content. This modification makes these models more appropriate to the task of simulating off-centerline receptor concentrations.

In the case of the EPA model, sector averaging has been utilized in even the short-term calculations. Since this assumes a crosswind spread of 22.5 degrees, it is inappropriate to make a crosswind modification that can be clearly consistent with the assumptions.

2.5 The INTERA Model

This model is a numerical solution of the three-dimensional material balances for the entire air stream and the pollutant flowing in that air stream [5]. It was developed originally by INTERCOMP and is presently utilized by INTERCOMP's environmental subsidiary, INTERA Environmental Consultants, Ltd. The pollutant material balance results from the turbulent diffusion equations which approximate turbulent fluctuations by a Fickian-type eddy diffusion model. The eddy diffusivity used in the model is height dependent consistent both with turbulent fluctuation measurements and theory.

The wind flow over uneven topography is calculated by numerically solving a modified form of the three-dimensional potential flow equations. The modification allows (1) inviscid potential flow at high elevations and (2) height-dependent coefficients which account for surface friction (viscous effects) in the lower boundary layer. The empirical modification causes the calculated windspeed to vary with height. This modification over flat terrain results in velocities which vary as either of two familiar forms, logarithmic or power law.

The numerical finite difference approach divides the region around the plant into a number of three-dimensional cells which can vary in size as terrain or meteorological characteristics require. The numerical procedures used in the solution of both the wind flow and pollutant flow are efficient, requiring minimal computer time. The steady-state solution, which is a good approximation to many practical problems, can be generated in a single time step or the entire progression to steady-state can be calculated in a series of time steps.

The modified potential flow model for wind flow calculations represents a significant simplification of the combined momentum and energy equations describing air flow. However, it retains the important factors necessary to a sound meteorological and engineering analysis of pollutant dispersion in rough terrain.

Of significance is the fact that over flat terrain the INTERA numerical model is in good agreement with the Gaussian models. This is true even though in the numerical model the diffusivities (and velocities) vary only with height unlike the Gaussian models where the standard deviations vary with distance downwind from the source. For constant coefficients, the Fickian or turbulent diffusion approach gives standard deviations which vary as

$$\sigma = \sqrt{2Ex/u}$$

where σ = standard deviation of pollutant dispersion
E = eddy diffusion coefficient
x = downwind distance from source
u = windspeed

The Gaussian models indicate σ varies in almost direct proportion to downwind distance, x. The fact that the turbulent diffusion model with height dependent diffusivities and velocities gives the same result as the Gaussian models implies that the additional downwind dependence of σ could be due to the assumption of uniform winds and diffusion over the thickness of the boundary layer.

The simplification of the momentum and energy equations used in the INTERA model cause some limitations in its use. These can be enumerated as

(1) the modified potential flow model prevents the formation of recirculating flow in the lee of an obstacle,

(2) the elimination of the energy balance prevents the actual calculation of natural convective flows.

The modified potential flow concept calculates good approximate velocity fields on the upwind side of obstacles. If the problem of interest is the recirculating flow, a more complete solution of the Navier-Stokes momentum equations is required. Such a model has been developed by INTERA[6] .

2.6 General Comparisons

Extensive comparison of the INTERCOMP model with Gaussian models have been made. As mentioned previously, it is essential that the numerical model be in approximate agreement with the Gaussian models for flat terrain. Particularly important is the need to have calculated concentrations decrease roughly as the square of downwind distance. Using well-accepted power law forms for the variation of velocity and diffusivity with height gives good agreement between the Fickian-type turbulent diffusion results and the various Gaussian model results. This is illustrated in Figure 1.

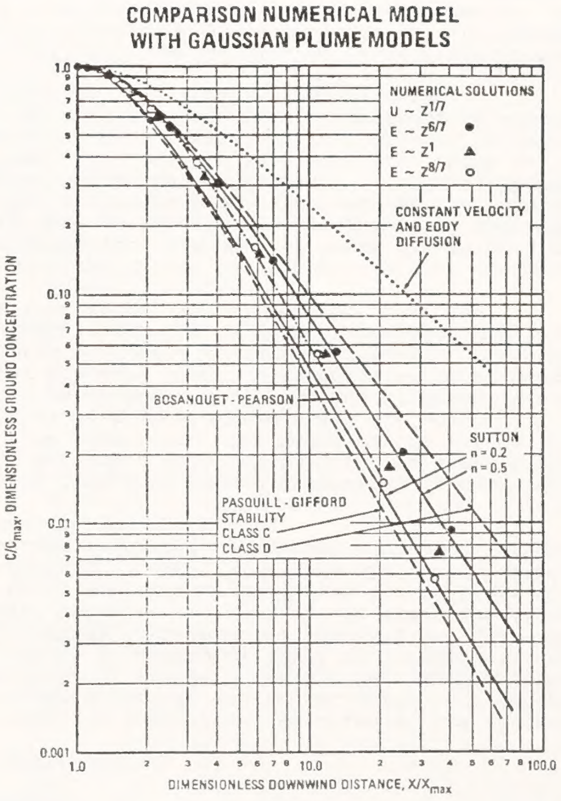


Figure - 1

Velocity and diffusivity height dependent forms have been determined with the INTERA numerical model which give good agreement with the Pasquill-Gifford stability classifications used in a Gaussian model. These values are as shown below:

POWER LAW FORMS WHICH

APPROXIMATE PASQUILL-GIFFORD STABILITY CLASSES

	A	B	C	D	E	F
Velocity Power	0.14	0.14	0.14	0.2	0.3	0.4
Diffusivity Power	1.76	1.38	1.14	1.0	1.0	0.67
E_{ref}, m^2/sec*	255	106	51	41	33	29
E_z/E_y	10	2	0.7	0.2	0.05	0.008

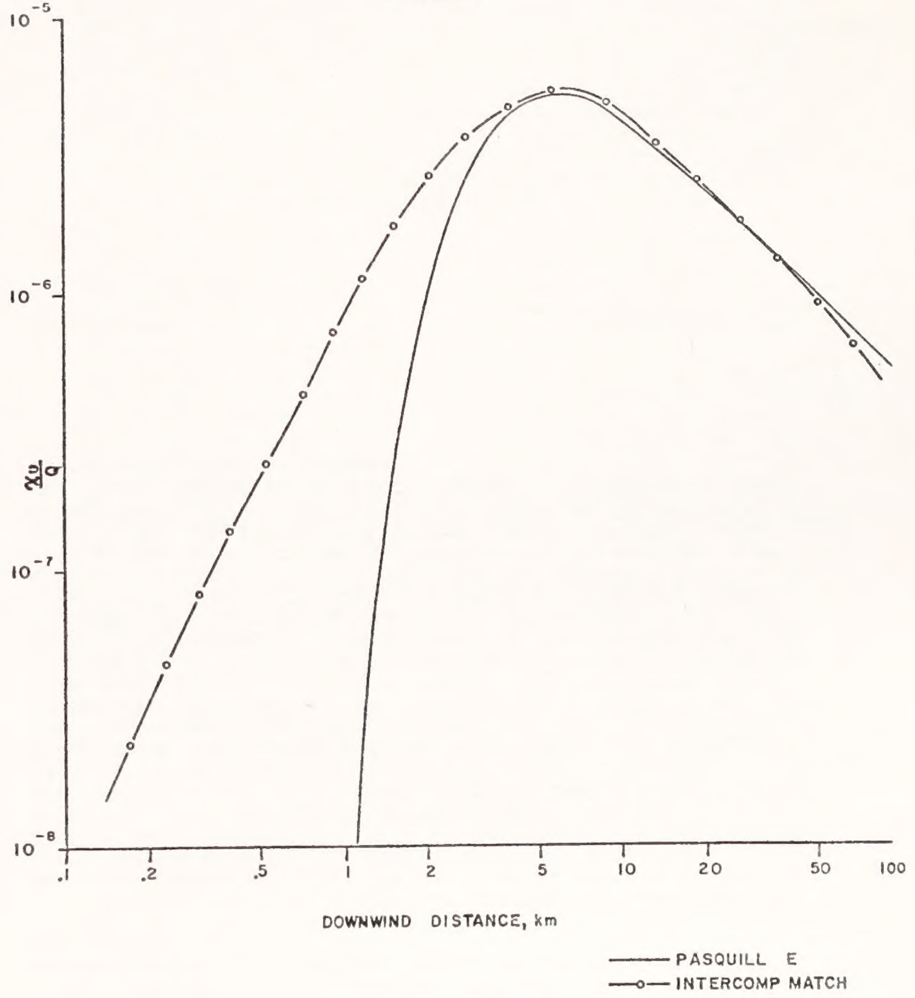
*Per 1 meter per second wind velocity at 10 meters above ground

The value listed as E_{ref} is for the horizontal cross-wind diffusivity at a reference elevation of 10 meters. As can be noted the above, there is roughly a factor of ten difference in the horizontal diffusivity over the range of atmospheric stabilities. Also apparent is the range in the ratio of vertical to horizontal diffusivities necessary for the various stability classes. The ratio of E_z/E_y should approximate the square of the ratio of σ_z/σ_y and for a downwind distance of 10 km or so this appears to be the case. In addition, for the analogy to be complete, the diffusivity values should be a function of the mean windspeed. The values listed above for E_{ref} are for a windspeed of 1 mps and should be increased or decreased in direct proportion to the mean windspeed at the reference height.

An example of a detailed comparison of the Gaussian and INTERA models for the Pasquill-Gifford E stability class is given in Figure 2. There is excellent agreement of the downwind falloff with distance. Upwind of the maximum, however, ground-level concentrations are significantly higher than the Gaussian. To a large extent, this difference is due to the power law wind profile which gives lower windspeed near the ground surface. The calculated concentrations in this region thus better approximate the effect of surface roughness. This deficiency in the Gaussian approach was discussed by Bowne[7] and a modification of the σ_y and σ_z curves was suggested. Such a modification results in increased concentrations upwind of the maximum and better agreement in Figure 2.

Figure 2

COMPARISON OF PASQUILL STABILITY CATEGORY E TO INTERCOMP MATCH OF THAT CATEGORY



Another basic difference in the Gaussian and the numerical model techniques is in the source configuration. In the Gaussian approaches, a point source is utilized at a calculated effective stack height. The TVA formulation of plume rise[4] has been primarily utilized in this study. Reference is also made to the Briggs method.[8] The INTERA numerical model must also rely on an external calculation of the plume rise for entry in the finite-difference grid system. The pollutant source rate is assumed uniform over the entire source block. This creates what is in effect a volume source and exhibits reduced concentrations compared to a point source along the plume centerline. Aerial plume measurements by many firms including North American Weather Consultants have confirmed this "initial dilution factor." Selection of the actual source block size and, therefore, the initial concentration is fairly subjective at present since adequate calculational "initial dilution factor" methods are only now being developed.

In the case of aerial tracer releases intended to simulate plumes, the problem of "initial dilution factor" is resolved easily. The source is actually a volume source. By allowing the source block to include the entire aircraft circular path, the volume source is excellently represented. In practice, four blocks were utilized to contain the aircraft path while maintaining block sizes necessary to adequate concentration solutions. In the Gaussian models, the representation of a volume source is not nearly as convenient. The normal approximation is to calculate the distance upwind that a point source would have to be located to account for the spreading observed at the source. This virtual point source distance changes with stability because spreading, as approximated by σ_y and σ_z, changes with stability. The volume source created by the tracer aircraft flying a tight circle is unfortunately not represented well by a single virtual source distance. The crosswind spread will always indicate a larger virtual distance than the vertical spread. That is, if the aircraft circular path diameter is set equal to 2.15 σ_y, representing 90 percent of the plume width, the downwind distance from the Turner curves for σ_y will always exceed the σ_z distance calculated the same way from the aircraft vertical oscillations. A compromise can be made by utilizing the crosswind area to approximate $4.62\pi\sigma_y\sigma_z$.

Another difference in the Gaussian versus the numerical methods arises in simulating two layer problems. Where the stability changes radically with height, the Gaussian models must resort to a reflection boundary. In the numerical model, velocity coefficients and diffusion coefficients can be changed at will. Surface based inversions can be entered below plume centerline or the base of an elevated inversion above. Diffusion and flow continue across the stability change boundary depending

on the relative coefficients on each side. More complex meteorological patterns can, therefore, be simulated with the numerical model.

The most critical difference between the numerical and Gaussian approaches is in the handling of terrain influences on pollutant dispersion. The INTERA model calculates a terrain induced wind field which is then used in the diffusion equation solution. This avoids the assumptions of parallel or horizontal flow which is made in the NOAA Gaussian approach or the judgment factor of 10 meters utilized in C4M3D. In order to understand these differences and test the accuracy of assumptions, the Environmental Protection Agency awarded a contract to INTERCOMP/INTERA to simulate with all three models field data from Huntington Canyon and El Paso.[9] The conclusion of that study was that in predictive situations the INTERCOMP/INTERA model gave accuracy in stable flows in terrain comparable to that obtained by Gaussian models in flat terrain, i.e. within a factor of 2 1/2. The Gaussian model predictions, however, averaged a factor of 15 higher than the measured results. No attempt was made with the numerical model to simulate more exactly the field data by altering diffusion coefficients from Pasquill-Gifford equivalents. The INTERCOMP/INTERA model would, therefore, appear to be a more appropriate prediction tool for stable situations in terrain.

3.0 SIMULATION OF METEOROLOGICAL TRACER STUDY

In May of 1974, extensive meteorological tracer experiments were undertaken by North American Weather Consultants at the proposed Kaiparowits sites. A total of ten tracer releases were made, seven at Fourmile Bench and three at Nipple Bench. Meteorological conditions encountered were mostly of neutral, unstable and slightly stable conditions. The very stable layers which did exist were not sufficiently deep to include the release heights. Both fluorescent particles and oil fog were released and the results of these experiments were evaluated for model simulation.

3.1 Fluorescent Particle Experiments

3.1.1 Selection of Cases for Simulation

A total of four fluorescent particle (FP) experiments were selected for model simulation. At the Fourmile Bench site, two of the tests, FM104 and FM107, were selected as being of sufficient interest from the point of view of rotorod samples of FP. Tests FM101, FM103, and FM105 did not have significant groundlevel concentrations of FP. Test FM104 differed from the remaining tests in that the majority of its concentrations were at greater downwind distances. It also was the only early morning release to show groundlevel concentrations when a shallow inversion layer was present. All of the remaining three tests were in unstable meteorological conditions. FM107 resulted in the highest FP value during the entire field program and was, therefore, selected out of the three to be a simulation case. The pattern of FP sampled values also appeared to be a lot more complete and consistent than for the other two cases.

Two simulation cases, NB102 and NB103, were selected at the Nipple Bench site. The remaining test had been eliminated because no significant FP values were found at groundlevel.

3.1.2 Simulation Approach

A general plan for proceeding with the simulations was adopted in order to have a consistently objective result in relation to the performance of each model. An initial estimate was made of the stability category that dominated the hour period during the field test. Each of the four models was run utilizing this stability category and the other meteorological variables. A predictive type of comparison was, therefore, obtained.

For the Gaussian models, the predictions were made with the windspeed and direction at the designated release height. A point source was assumed at the center of the tracer aircraft's circular path. All values were calculated in FP particle number counts utilizing the release rates and FP per gram assay's supplied by North American Weather Consultants. A rotorod sampling rate of 52.1 liters per minute and a collection efficiency of 60 percent were assumed. In addition, a uniform sampling time of one hour equal to the time of release was assumed. The few sequential sampler data that are available indicate that FP did accumulate over a somewhat longer period of time. The one hour period is, however, conservative and can be accepted as reasonable applicable to all the models.

In the INTERA model, the prediction was carried out by utilizing diffusion coefficients which are equivalent to the selected Pasquill-Gifford stability class for a flat terrain situation. The typical windspeed profile for the selected stability class was entered with the specified windspeed at the release altitude (as well as the wind direction). The grid block in which the source rate enters the computations was kept small. The terrain is represented as a single value for each horizontal grid. The actual value is determined from a fine mesh grid digitized from the 1:250000 scale USGS map of the Kaiparowits site area. The TVA model is also utilized with the terrain through an altitude for each receptor point. The NOAA and C4M3D models, however, assume flat terrain in all nonstable conditions and were so used.

Comparison of these initial predictive results was the next step undertaken. Several statistical measures were chosen to help evaluate the relative performance of the models. These are described here for use throughout this section:

(1) Correlation coefficient (r) - Measure of the correspondence of the observed and calculated values indicating how well the calculated values follow the linearized increase in the observed values. Since observed and calculated can be very different in magnitude and still have a perfect correlation of 1, other tests are required.

(2) Ratio (RATIO) of mean calculated to mean observed values - This provides a measure of the relative magnitudes lacking in the correlation coefficient.

(3) Logarithmic mean value ratio (ln mean) - A measure of the ability to simulate the downwind falloff of the observed values. If the observed and calculated were plotted on a $\chi u/Q$ log-log plot, the ln mean would be the multiplication factor to obtain the observed falloff. 1 is the perfect result.

In addition, it was desirable to simulate the values of the highest observed samples reasonably well. Since the ultimate goal is a prediction of maximum potential groundlevel concentrations, this last factor is given considerable weight as the simulation process proceeds.

All FP receptors with observed values in excess of 10FP were initially included in the statistics. Recognizing that 10FP is below the significance level for a sample, it was felt that the lack of FP at some locations could also be important. Additionally, the larger number of samples provides for a better visualization of the FP pattern at groundlevel.

The lack of crosswind flexibility in C4M3D requires special processing for comparisons to the FP data. A graph of calculated values with downwind distance was prepared. All the FP samples within a 22.5° arc of the input wind direction were located on the graph by their distance from the source. A value from the calculated curve at that distance was used for the comparison to the observed. Values outside the arc were not utilized.

Once the predictive mode has been completed, the models are adjusted individually to provide the best possible simulation within the limits of model flexibility. The NOAA, TVA and INTERA models can all be adjusted for wind direction to obtain a best fit with that parameter. It can be appreciated that modifications within ten to twenty degrees of the pibal derived wind direction are acceptable. None of these models adequately account for the changes of wind direction with height. Windspeed can also be varied within the framework of the pibal data. During most of the tests, three pilot balloons bracketed the one hour release. Wind conditions often changed substantially within the period. The C4M3D does not have an option to switch wind direction within a 22.5° arc, but windspeed could be varied. The INTERA model was generally forced to simulate the actual

windspeed profile with height through variation of the power law value. A log-log graph of the pibal data provided a means to approximate a good power law fit. Where negative slopes (decreasing speed with height) were found, the power law was eased a little to avoid excessive winds at the ground surface.

It was also allowable for any of the four models to completely change stability class. The INTERA model has the greatest flexibility in this regard since the diffusion coefficients can vary linearly not just discretely from class to class. The INTERA model was allowed to seek its best diffusion coefficients to simulate the FP data. If, however, the INTERA advanced in coefficient magnitude beyond the next discrete stability class, the Gaussian models were at least attempted at that new class.

Additionally, the simulation process allowed each model to account for the initial distribution of the plume in its own manner. The INTERA model used four equal sized blocks to approximate the circular FP tracer aircrafts path. The Gaussian methods employed a virtual point source concept. An area of 600 meters in the y direction and 60 meters in the vertical was allowed for the FP aircraft. By using

$$\frac{Xu}{Q} = \frac{1}{2\pi\sigma_y\sigma_z} = \frac{2.31}{A} = \frac{2.31}{600X60} = 6.45x10^{-5}$$

Where $A = 4.62\pi\sigma_y\sigma_z$ the values of the virtual source are for each stability:

VALUES OF VIRTUAL POINT SOURCE
CORRECTION FACTOR FOR FP AIRCRAFT

STABILITY	A	B	C	D	E	F
FACTOR m	250	380	580	1100	1800	3200

All of the above considerations were attempted in varying degrees to attain simulations of the FP data. The values of the statistics were calculated all along to provide measures of improvement from one attempt to the next. As a practical matter, the values of the largest FP samples are watched very closely. When it appears that further modifications are not improving the simulation, the process is concluded. The models are then compared again utilizing the statistics and their relative merits weighed.

Once the simulation had been reached with each of the models, an additional statistical evaluation was attempted. Removed from the list of FP samples were all those below 50 FP. These were judged by NAWC to be of lesser significance. Additionally, a limited number of FP observations which were judged unreasonable to simulate with any of the models were eliminated. Most of these were small values in the midst of high concentrations or large values at extreme angles to the nominal wind direction. The statistics were run again to provide a more refined check of the relative model performance.

3.1.3 Test NB102

Direct reference is made in the following sections to the detailed descriptions of the tests made in the North American Weather Report on these FP tests. In the case of NB102, it was felt that C stability would be an initial condition. The temperature profiles at both Fourmile Bench and Nipple Bench had slightly unstable lapse rates, but the high windspeeds involved would have seemed to preclude B stability. The input meteorological and release conditions are outlined in Table I.

It can immediately be seen from Table II that the predictions based on C stability are poor. All of the models placed the maximum too far downwind. The Gaussian models were underpredicting the values at many positions especially those close to the release point. The INTERA model was overpredicting in many cases, while underpredicting the maximum values.

The wind profiles as represented by the pibals gave an erratic picture. While the winds started strong, they decreased during the period. Even the initial profile showed a decrease of wind speed with height up to 300 meters above ground. If a power law were fit to a decreasing profile, it would have exhibited a strongly negative slope. It was surmised, however, that the balloon could be rising in a convective thermal thereby presenting the appearance of slower windspeed. A uniform profile with height was finally utilized as being most indicative of the situation. Attempts were made to reduce the windspeeds in all the models consistent with the lower windspeeds in the last two pibals and the windspeeds normally associated with unstable activities. None of the models responded nearly

TABLE I

MODEL INPUT VALUES NB102

	INITIAL	FINAL
Basic Stability Class	C	A
Wind Velocity mps*	12.0	12.0
Wind Direction °True*	263°	270°
Velocity Power	0.14	0.0
Diffusivity Power	1.14	0.0
$E_{ref}, m^2/sec$	1016	6000
E_z/E_y	0.67	2
Virtual Source (m)	0	380

*Release Height	366 m
Source Strength (FP)	3.97 gm/sec
Assay	2.31×10^{10} FP/gm

TABLE II

COMPARATIVE MODEL RESULTS

FROM NB102

	STATISTICS			
	N	r	RATIO	ln mean
Prediction				
NOAA	20	-.215	.705	1.455
TVA	20	-.181	.505	.961
C4M3D	8	-.659	1.530	4.671
INTERA	20	.022	1.650	1.406
Simulation				
NOAA	20	.118	2.040	.668
TVA	20	.002	.030	.406
C4M3D	7	.809	2.520	3.230
INTERA	20	.556	1.610	2.594
Final Simulation				
NOAA	13	.228	1.250	.354
TVA	13	.158	.020	.260
C4M3D	4	.844	2.140	1.908
INTERA	13	.747	1.120	1.317

N = number of receptors evaluated

so well to windspeed decreases as to stability class changes. By moving all the models to essentially A stability and retaining the high windspeed, the best simulations were obtained. This result indicates that highly unstable diffusion coefficients can coexist with neutral lapse rates. It seems likely the mechanical turbulence is involved.

A wind direction shift of 7° to 270° True was beneficial to all the models in simulating the sampled FP values.

The process of moving toward a simulation with the INTERA model involved moving the distance to the ground-level maximum in toward the source through increases in the diffusion coefficients. Once the coefficient reached the next higher stability category the Gaussian models were run at that category and the values checked.

Aside from the 5 values that were less that 50 FP out of the original twenty, two others were eliminated from the final statistics. These were LP1013 and BCNB14 which were very close to the expected plume centerline and maximum, and yet had very low FP values. None of the models matched these points at all accurately. BCNB14 has a value of 90 FP and is only 122 meters from LP1018 which had a value of 1214 FP, an improbable situation to simulate with a steady-state model. Perhaps these samples represent areas where thermal updrafts formed throughout the tests. A convective model and much more meteorological data would be required. By the same token, downdrafts may have been involved in this convective activity producing the high values. In that case it is the more conservative approach to accept the high points as valid and eliminate the low ones from the averaging process.

The statistics presented in Table II under Final Simulation indicates the final simulated results. The NOAA model does fairly well in calculating the RATIO of mean calculated to observed values, but its correlation is quite low. By decreasing windspeed, the correlation can be brought up but the ratio gets much larger. The TVA model based on neutral situations cannot hope to simulate a highly unstable atmosphere. The INTERA model has managed a reasonable correlation and a good ratio of calculated to observed. The C4M3D model has managed an even higher correlation while overpredicting all the points. The small sample size available is also a factor. When the INTERA results are compared for the same for points, it receives a correlation of .899 and a ratio of .80. A review at all the individual monitor sites is available on Table III.

TABLE III

SIMULATION RESULTS NB 102

ALL VALUES IN FP

SITE	OBSERVED	INTERA	NOAA	TVA	C4M3D
LP 1011	119	535	91	0	
LP 1012	219	693	2690	1	
LP 1013*	80	467	97	0	
LP 1016	87	195	1	0	
LP 1017	257	384	322	0	
LP 1018	1214	536	1812	18	
LP 1019	213	257	134	0	
SH 1005*	36	42	1	0	82
SH 1006	60	44	2	1	80
SH 1016*	10	103	11	0	
TRNB 05*	19	160	72	71	
BCNB 13*	24	1148	2001	0	
BCNB 14*	90	536	1717	14	
BCNB 15	66	273	81	0	
BCNB 25	1278	1320	0	0	
SHJ 01	250	276	195	43	760
SHJ 02	282	164	44	0	430
SHJ 03	170	116	2	0	
SHJ 06*	19	37	0	0	290
SHJ 08	70	88	13	0	150

*Sites deleted in final statistics

It is also instructive to look at the maximum values and distances computed by each of the models. These are presented in Table IV. The maximum FP value also shown occurred directly under the aircraft at the center of its circular path. This fact in itself adds to the hypothesis of extremely unstable conditions with the potential of thermal cells. The INTERA model, with four grid blocks representing the aircraft path was able to simulate that peak value with a value of 1320 FP. The Gaussian models, even with the correction for a virtual source, were unable to get any concentration at that location.

The maximums found by the model simulations are not excessive in terms of the expected source. The formulation used is:

$$X_{SO_2} = \frac{D_{FP}}{Q_{FP}} \times \frac{Q_{SO_2}}{ASSAY} \times 1000$$

$$X_{SO_2} = \frac{FP}{Q_{FP} \times ASSAY} \times 1.13\times10^3$$

where X_{SO_2} = equivalent concentration in SO_2 in $\mu g/m^3$

D_{FP} = dosage of FP (see NAWC section 3.2) in FP/1

FP = fluorescent particles, i.e. model output

Q_{FP} = release rate of fluorescent particles in grams/sec.

Q_{SO_2} = emission rate of SO_2 in grams/sec. a value of 530. grams/sec used (3000 MWe)

ASSAY = fluorescent particles per gram as determined by assay

The maximum INTERA value of 1614 FP is equivalent to 20 $\mu g/m^3$ of SO_2 while the NOAA result of 4950 FP is equivalent to 60 $\mu g/m^3$.

TABLE IV

	Maximum FP	Distance m
FP Sampled Data	1278	0
NOAA	4950	980
TVA	2110	11400
C4M3D	1860	6250
INTERA	1614	300

3.1.4 Test NB103

A second mid-morning test was conducted at Nipple Bench on May 11. A smaller number of fluorescent particle rotorod sites actually received dosages than during the NB102 flight. The temperature profile was more nearly adiabatic. The photographic evidence and rapid dispersal downwind indicated, however, relatively intense diffusion. An initial stability class of C was again selected to go with the input data in Table V.

In this case the initial test with C stability or its equivalent gave much more encouraging results. Table VI details the statistics. The Gaussian models were for the most part overpredicting those few values for which FP calculations were obtained. The INTERA model overpredicted for the monitors which did receive FP but had much better correlation because more sites were involved.

The windspeed profiles obtained by pilot balloons were reasonably consistent throughout the period. A velocity power of 0.2 fit the 11 a.m. pibal sounding reasonable well and was utilized in the INTERA model. The wind direction from the pibals varied from 220° to 270° during the test. This is apparent from the pattern of isopleths of groundlevel measurements in the North American study. Some fine tuning of the wind direction was, therefore, in order. Although the wind direction change assisted three of the models in raising this correlation coefficients, it did not provide a complete answer. The rotorod samplers LP1106, LP1107, and LP1112 all lie well north of the plume path chosen. For the period of time during the test in which the winds were from 220°, these rods accumulated FP. The steady-state approach makes it difficult to develop those values so far off the plume centerline. This problem is further observed when attempting to evaluate the C4M3D model. Only three monitors lie within a 22.5° arc of the plume centerline. No change could be made in its parameters in going to the simulation. As a comparison, the INTERA model for those same three monitors had a correlation of .999, a ratio of 1.693 and a ln mean of 1.262.

The Gaussian model results, both NOAA and TVA, are extremely hampered by the excess width to the plume. The INTERA model has many more useful values and, therefore, maintains a better correlation throughout the simulation process. The final mean ratio and ln mean statistics are also much better for the INTERA model. A presentation of results (Table VIII) is provided for more complete inspection.

TABLE V

MODEL INPUT VALUES NB 103

	INITIAL	FINAL
Basic Stability Class	C	C
Wind Velocity mps*	5.1	5.1
Wind Direction °True*	248°	253
Velocity Power	0.14	.20
Diffusivity Power	1.14	1.60
E_{ref}, m^2/sec	242	242
E_z/E_y	.67	.67
Virtual Source (m)	0	580

***Release Height**	610m
Source Strength (FP)	2.80 gm/sec
Assay	1.77×10^{10} FP/gm

TABLE VI

COMPARATIVE MODEL RESULTS

FROM NB 103

			STATISTICS	
	N	r	RATIO	ln mean
Prediction				
NOAA	12	.254	1.294	.936
TVA	12	.413	.420	1.159
C4M3D	3	-.111	2.318	1.819
INTERA	12	.796	1.730	.994
Simulation				
NOAA	12	.696	.359	.758
TVA	12	.813	.480	.642
C4M3D	3	-.111	2.318	1.819
INTERA	12	.817	.806	.912
Final Simulation				
NOAA	7	.760	.545	.621
TVA	7	.888	.072	.468
C4M3D	3	-.111	2.318	1.819
INTERA	7	.911	1.220	.843

N = number of receptors evaluated

TABLE VII

SIMULATION RESULTS NB103

ALL VALUES IN FP

SITE	OBSERVED	INTERA	NOAA	TVA	C4M3D
TRNB 17*	30	19	135	1	0
BCNB 05*	10	0	0	0	
BCNB 06*	14	0	0	0	
LP 1103*	25	45	0	0	
LP 1104*	11	15	0	0	
LP 1105	407	718	323	60	245
LP 1106	141	0	0	0	
LP 1107	82	0	0	0	
LP 1109	67	16	0	0	
LP 1110	100	155	1	0	1000
LP 1111	201	60	0	0	
LP 1112	186	0	0	0	

*Sites deleted in final statistics

TABLE VIII

	Maximum FP	Distance m
FP Sampled Data	407	4300
NOAA	1904	8354
TVA	2549	11438
C4M3D	992	7050
INTERA	2130	5795

Maximum values and distances are presented in Table VIII. Again, the TVA model has been hampered by insistence on a far downwind maximum. The equivalent SO_2 concentrations are 50 micrograms per cubic meter for the INTERA maximum and 58 $\mu g/m^3$ for the TVA.

3.1.5 Test FM104

This test represents the most interesting case during the field test program. A strong surface inversion was observed at the beginning of the test at Fourmile Bench and had been observed the previous hour at many locations. After the test, surface heating had been sufficient to eliminate the inversion. The process of fumigation would at least have occurred through the shallow inversion layer. The very fact that 18 monitors had measurable amounts of FP attests to the elimination of the inversion. Test FM103 immediately prior to this one had only one groundlevel value primarily because of the inversion layer.

The release of FP was certainly into a neutral layer above the inversion. The natural place to begin then is with D stability or its equivalent in the numerical model. Those input parameters are detailed in Table IX. The calculations resulted in all the models having correlations of about .5. The INTERA model was noteworthy for its overestimation of the concentrations especially those closer to the source. Some alteration of wind direction was immediately found to be of benefit to the INTERA. Although this same change was applied to the NOAA and TVA models, it did not improve the results. Although a change to E stability for the Gaussian models was tested, it was also ineffective in improving the results. The C4M3D had reasonable looking values, but failed to even provide an envelope for the FP counts within its 22.5° arc.

The observed wind profile was consistent with that observed normally at F stability. This profile was utilized in the INTERA model. It was apparent from the pattern of FP data that diffusion was more limited than D stability. When the model was tried with coefficients indicative of E, the performance improved considerably. The real atmosphere situation during the test was one of two distinct layers, each with differing diffusion properties. Since the INTERA model can be utilized to simulate such a situation, it was attempted. The result was slightly better performance than the all E stability approximation and this run was used as the simulation in Table X. In Table IX, the two layers' diffusion coefficients are specified with the stable layer first. This added flexibility and gave it an edge over the other models in the simulation statistics.

The next step is to eliminate those FP values that were below 50 FP and the extraneous values. It had been hoped the numerical model would be able to simulate the data obtained on the ridge line north of the release site on Fourmile Bench. This did not occur since the wind flows the model produced in the stable situation were all slanted down toward the lake rather than north toward the ridge line. None of the models, therefore, came close to touching those values. Perhaps the wind headed in that direction temporarily. Even short transients could account for the FP since the monitors were at centerline distance. Eliminated from the final statistics were SHR401, SHR402 and the sequential sample at SSNE-13.

The final statistics show generally good values for both the NOAA and INTERA models. The only difference is in the logarithmic mean ratio. This suggested that on a log plot versus downwind distance, the INTERA results would much better approximate the falloff of observed values.

Table XI provides the actual calculated values for more detailed comparisons. One very important point to note is the calculations for FP sampler SHR418. The observed value was only 39 and was, therefore, eliminated from the final statistics. That sampler was located on the Kaiparowits Plateau. NAWC figure 4.2-15 shows these relative positions of the monitors on the Plateau, i.e. SHR4-16 to SHR4-19. The plume which had a maximum value of 1507 FP at SHR4-14 must have passed over one of the in the outer arc samplers. It would appear from the value at SHR4-18 that the plume passed closest to it. All of the models predict continued high concentrations as the plume passes over the Plateau. Why were the values so small? No logical path could have steered the plume entirely away from monitors. Perhaps the sites were protected from FP by a strong surface stable layer. Perhaps aerodynamic effects of the cliffs are important. The available data does not appear to offer a reasonable explanation of this dilemma. The lack of measurement holds some expectation that plume interaction with this specific piece of terrain may be negligible.

Pursuing this dilemma a little further, it was decided to simulate FM103. By utilizing an F stability layer close to the earth's surface, it was expected that the FP would be prevented from getting to groundlevel from the elevated release. Although that was found to be the case, calculated groundlevel FP values remained significantly above the measured FP counts. A large area was calculated to have FP exceeding 1000 while the maximum measured was 54. North American Weather Consultants also measured the downwind concentrations of oil fog utilizing a nephlometer. Plume centerline values indicate a more

TABLE IX

MODEL INPUT VALUES FM104

	INITIAL	FINAL
Basic Stability Class	D	D
Wind Velocity mps*	5.3	5.3
Wind Direction °True*	260°	254°
Velocity Power	0.20	0.40
Diffusivity Power	1.00	1.33
E_{ref}, m^2/sec	382	200/382
E_z/E_y	0.17	0.05/0.17
Virtual Source (m)	0	1100

*Release Height	366m
Source Strength (FP)	3.91 gm/sec
Assay	2.31×10^{10} FP/gm

TABLE X

COMPARATIVE MODEL RESULTS

FROM FM104

	STATISTICS			
	N	r	RATIO	ln mean
Prediction				
NOAA	18	.504	.787	.692
TVA	18	.574	1.477	1.042
C4M3D	7	.254	1.064	2.433
INTERA	18	.468	1.914	.827
Simulation				
NOAA	18	.515	1.220	.579
TVA	18	.529	1.562	1.039
C4M3D	7	.254	1.064	2.433
INTERA	18	.725	1.165	.791
Final Simulation				
NOAA	8	.833	.871	.268
TVA	8	.532	1.319	.666
C4M3D	5	.248	.785	1.105
INTERA	8	.812	.942	.839

N = number of receptors evaluated

TABLE XI

SIMULATION RESULTS FM104

ALL VALUES IN FP

SITE	OBSERVED	INTERA	NOAA	TVA	C4M3D
TR 03*	12	95	0	0	
TR 22*	50	0	0	0	
TR 23*	37	0	0	0	
TR 24*	51	1	0	0	
TR 25*	48	14	0	0	
TR 26	521	123	1	0	
TR 27	435	666	673	1477	370
SHR 401*	85	1	0	0	
SHR 402*	59	2	0	0	
SHR 403	128	164	35	5	
SHR 404	924	1424	1387	3141	525
SHR 405*	29	602	1	0	525
SHR 412	77	192	4	0	750
SHR 413	1037	746	400	87	750
SHR 414	1507	1120	1625	1543	730
SHR 415	108	28	0	0	
SHR 418*	39	975	2322	2002	660
SSNE 13*	137	0	0	0	

*Deleted in final statistics

TABLE XII

	Maximum FP	Distance m
FP Sampled Data	1507	20600
NOAA	2560	29200
TVA	14957	5788
C4M3D	750	24000
INTERA	1960	20250

stable atmospheric condition than the temperature profiles reveal for FM103. Certainly a very stable plume could have completely avoided interaction with the ground resulting in very small rotorod counts.

The maximum values for each of the models are presented in Table XII. They suggest that the NOAA and INTERA models are reasonably on target in the simulation. The C4M3D suffers from sector averaging of concentrations while the TVA model has misplaced the maximum and seriously overestimated the concentration. An equivalent SO_2 concentration of 25 micrograms per cubic meter was found for the INTERA maximum and 30 micrograms per cubic meter for the NOAA model.

3.1.6 Test FM107

The mid-morning release on May 6 was visually found to be a looping plume. The strong vertical transport indicated in the NAWC description was verified by the aerial oil fog measurements. These showed puffs of oil fog at three different heights, the bottom puff being quite close to the ground. The initial trial was run at B stability. The input values are detailed on Table XIII while the results are presented in Table XIV. These predictive results were relatively poor with each of the models. The C4M3D returned the best results, but this was primarily because its 22.5° sector did not include the two highest concentration values close to the source.

The wind speed and direction were highly variable during the test period. The three pibals which were taken show windspeeds ranging from 2 to 5 meters per second at the surface and 1.2 to 17 meters per second at the release height. This makes selection of a proper velocity power difficult. The change of wind speed with height in succeeding pibals goes from decreasing to near uniform to strongly increasing. It was decided to utilize the normal unstable profile which is somewhat consistent with the mid-test pibal. Selection of an average wind direction is also a problem in the light and highly variable winds. Release height directions vary from 100° to 160° while groundlevel directions are more southerly.

The only feasible way of improving the wind simulation was to let the best fit of the data determine parameters. In order to obtain high concentrations immediately adjacent to the source location, a windspeed at the low end of the pibal determined range of values was required. The two highest concentrations at LP23-13 and LP23-14 are northeast of the source and lie out of the main direction

TABLE XIII

MODEL INPUT VALUES FM107

	INITIAL	FINAL
Basic Stability Class	B	A
Wind Velocity mps*	4.0	2.0
Wind Direction °True*	160°	170°
Velocity Power	0.143	0.143
Diffusivity Power	9.86	9.86
E_{ref}, m^2/sec	771	494
E_z/E_y	2.00	2.00
Virtual Source (m)	0	250

*Release Height	578 m
Source Strength (FP)	2.7% gm/sec
Assay	1.77x10^{10} FP/gm

TABLE XIV

COMPARATIVE MODEL RESULTS

FROM FM107

	N	r	RATIO	ln mean
		STATISTICS		
Prediction				
NOAA	20	-.193	1.176	1.339
TVA	20	-.163	.305	1.359
C4M3D	6	.207	.750	1.103
INTERA	20	-.090	.921	.987
Simulation				
NOAA	20	.498	.876	.281
TVA	20	-.069	.02	.664
C4M3D	4	.433	11.667	8.660
INTERA	20	.315	1.925	1.389
Final Simulation				
NOAA	12	.573	.607	.084
TVA	12	-.052	.01	.857
C4M3D	4	.433	11.667	8.660
INTERA	12	.737	1.085	1.018

N = number of receptors evaluated

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of plume movement. They are probably the result of the highly convective active which brings puff clouds of tracer to the ground. It is necessary while trying to provide a steady-state simulation of these points to go to a wind direction of 170°.

When selections were made for FP sites to delete, there was the same dilemma as in the other unstable cases. Low values were found at several locations which were near the maximums. TR17 and BC02 are both examples where both NOAA and INTERA models gave very much higher values than those observed. In order to remain on the conservative side of this meteorological situation the low points were eliminated and the high points retained. Site LP23-15 sits well off to the east of the source location. A significantly wider plume would have been required to simulate that site. In the INTERA model, that much wider a plume reduces the ability to simulate the entire set of data.

In simulating the data, the models differed in basic stability class. The INTERA model achieved the best results with the initial B stability parameters modified only for a reduced windspeed. The NOAA model, however, achieved significantly better results at A stability. This difference is primarily because of the higher numerical model results upwind of the maximum concentration.

In reviewing the final statistics in Table XIV, the INTERA model again had the highest correlation coefficient. It also well approximated the general size of the measured concentrations as evidenced by values near 1 for both the mean and ln mean ratios. Looking at Table XV shows that the values at the two highest points, when compared, are reasonable especially comparable with the values obtained in the NOAA model results. Both the TVA and C4M3D models have again shown their inflexibility in simulations. The TVA could match the data better if an unrealistically low windspeed were used while the C4M3D could simulate the few points in its arc at an unrealistically high windspeed. Even then, the C4M3D would ignore the peak concentrations.

Table XVI presents the maximum value data for each of the models. Since the FP data is certainly not centerline it could be expected the maximums would be a lot higher. The NOAA value is, again, based on A stability and would only be 6500 FP if B were used. The INTERA model SO_2 equivalent is 90 micrograms per cubic meter which the NOAA model result equals 365 micrograms per cubic meter. The highest measured FP value (which also represented the highest during the entire set of tests) was

TABLE XV

SIMULATION RESULTS FM107

ALL VALUES IN FP

SITE	OBSERVED	INTERA	NOAA	TVA	C4M3D
TR 01*	37	844	132	0	
TR 15*	31	699	196	0	
TR 17*	77	3884	1514	52	4000
TR 35*	13	3	0	0	
TR 36	101	78	3	0	
BC 01	209	527	4	0	
BC 02*	382	3209	1378	1	3000
BC 03	441	1120	242	69	4800
BC 04	98	316	41	0	
BC 05	191	231	23	0	
BC 06	154	50	2	0	
LP 23-10*	33	4	0	0	
LP 23-11*	42	63	2	0	
LP 23-12	176	58	3	0	
LP 23-13	2601	1141	107	0	
LP 23-14	2037	2863	3726	0	
LP 23-15*	924	81	0	0	
SH 56-03	278	134	1	0	
SH 56-04	470	216	63	0	
BC 28G	180	793	0	0	0

*Sites deleted in final statistics.

TABLE XVI

	Maximum FP	Distance m
FP Sampled Data	2601	926
NOAA	15911	979
TVA	6738	11438
C4M3D	4800	3600
INTERA	3950	1525

equivalent to 60 micrograms per cubic meter. This is the only simulation in which the windspeed at the release height was reduced from the initial pibal value. The initial pibal was utilized in order to determine the release height appropriate to the expected Kaiparowits plume. The actual plume would have risen higher during the one hour release and measured groundlevel concentrations would have been less than those found by this preselected aircraft release. The equivalent concentrations reported above, therefore, overestimate expected plume performance during the same one hour period.

3.1.7 Summary

The fluorescent particle tracer experiments provided validation exercises for unstable and neutral to slightly stable atmospheric conditions. The four models tested differ most substantially in their approach to stable atmospheric conditions. The simulation results do not clearly speak to those differences. Only in the case of NB104 was a stable layer used in the INTERA, but it only slightly improved performance over a neutral stability approach.

For the neutral and unstable conditions present in the FP tracer tests, the major model differences were in concentrations between the source and the maximum. Although some terrain differences were involved, it is believed that lack of surface roughness in the Gaussian models is responsible for their difficulties. Turbulence near the surface is increased and windspeed near the surface are decreased due to the affects of very rough terrain. The INTERA model has an advantage because it accounts for some of these differences.

The statistical results indicate that in each case the INTERA model results were better than the Gaussian models in overall performance. Although a Gaussian model might exceed the INTERA in one statistic, taken as a whole the INTERA values are better. It is somewhat debatable whether the differences are truly significant in light of the difficulties in modeling, the complexities of the situation and the necessary assumptions in FP tracer work. The differences to some degree reflect the ease of simulation with the INTERA model compared with the more predictive nature of the Gaussian models. The INTERA model was certainly better able to simulate the peak values in the FP data much more accurately than the Gaussian models.

The SO_2 equivalence concentrations indicate no difficulty in meeting ambient air quality standards based on the results of these tests. A maximum of 90 micrograms per cubic meter was found by the INTERA model in FM107. It is probable, however, that the actual power plant would have had a higher plume rise in the same situation. The 90 micrograms per cubic meter equivalent sulfur dioxide is, therefore, somewhat conservative.

4.0 PREDICTIONS

The tracer experiments at Fourmile Bench and at Nipple Bench investigated primarily unstable, neutral and slightly stable meteorological conditions. Very stable, limited mixing and fumigation situations were not found. Each of these latter three are potentially responsible for higher groundlevel concentrations. At any particular site, the "worst" meteorological condition might be any one of the three dependent on the local situation with respect to terrain, climatology, stack parameters or other specifics. In the case of the two proposed Kaiparowits sites, it is necessary to study each of the potentially "worst" meteorological conditions using an appropriate model. The INTERA model was shown in the previous section to be slightly better at simulating measured groundlevel concentrations. One result of interest was that the INTERA model simulates the values upwind of the groundlevel maximum much more realistically than Gaussian based models. Since some of the predictions are going to involve high concentrations on the Bench close to the proposed power plant, it would appear more advisable to utilize a model which simulates such values well. There is also less danger of underpredicting these close to the plant values since the INTERA concentrations are higher than the Gaussian. Selection of the INTERA model for stable cases must be predicated on the simulation of Huntington Canyon data for EPA.[9]

The meteorological conditions which are potentially "worst" cases were reviewed at both sites. Model predictions were made for the cases which appeared to be significant. This section is organized by atmospheric stability situation and values for each of the proposed sites are jointly discussed.

4.1 Stable

Stable atmospheric conditions reduce both the rise of a heated plume into the atmosphere and the vertical diffusion of that plume. On flat terrain, the pollutant diffuses slowly to the groundlevel; the maximum is, therefore, at great distances downwind where horizontal diffusion has reduced concentrations substantially. In rough terrain where elevations exceed the release height, the concern is that higher groundlevel concentrations will result from interaction of the plume and the terrain. Elevations significantly above stack base heights occur in the Kaiparowits area and an investigation of stable conditions is warranted.

The available climatology shows a high percentage of slightly stable occurrences in the early morning for the expected plume altitudes (600-2000 feet above ground). Utilizing this as a basis for predictive calculations, E stability was selected. It is natural to expect that the highly rough terrain features in the area create turbulence which prevents true F stable situations from forming at the expected plume elevations. This fact is confirmed by the 200 aircraft temperature measurements in the proposed site areas. No lapse rates indicative of F stability were found through plume heights. From each of the proposed Kaiparowits sites several directions were selected in which terrain elevations were sufficient to interact with plumes headed toward them.

A windspeed of three meters per second was selected as a lower limit for the stable plume calculation. A slightly stable potential temperature lapse rate of 2.0°C per 100 meters was utilized. This gives TVA calculated plume rises of roughly 270 meters. At Fourmile Bench, this results in an effective source height of 7500 feet MSL and at Nipple Bench the height is 6900 feet MSL. Lower windspeeds give even higher plume rises while higher windspeeds give more rapid dilution.

The input data and the results of the calculations are shown for both proposed sites in Table XVII. The highest sulfur dioxide concentration for a 3000 MW power plant was a scant 46 micrograms per cubic meter at either site. In order to test the sensitivity of these predictions both Briggs plume rise (175 meters) and F stability were used. For the Fourmile Bench site at a wind direction of 175°, a maximum of 68 micrograms per cubic meter was found. For the Nipple Bench site at a wind direction of 148° a value of 69 micrograms per cubic meter was found.

These results are very small and indicate that either site would have little difficulty in meeting ambient air quality standards during stable conditions.

4.2 Unstable

Unstable atmospheric conditions are most like those observed during the tracer tests. A looping plume develops in which puffs of concentration may be taken up or down by convective cells. A steady-state approximation to this type of convective activity leads to the concentrations in Table XVIII. These results are consistent with the concentrations found during the tracer tests. The wind directions were selected for the maximum groundlevel concentrations, which at both sites occured on the source Bench.

4.3 Limited Mixing

In the limited mixing case, an elevated inversion is assumed in which the layer below is adiabatic or well mixed and the atmosphere above the inversion base is stable. In the INTERA model we have utilized an equivalent B stability layer below the inversion base and an E stability equivalent

TABLE XVII

STABLE PLUME PREDICTIONS

SULFUR DIOXIDE GROUNDLEVEL CONCENTRATIONS

EQUIVALENT STABILITY CLASS, E

	Fourmile Bench	Nipple Bench
INPUT DATA (3000 MWe)		
Base Height (m,MSL)	1860	1585
Stack Height (m)	183	244
Winds (m/sec)	3	3
Lapse Rate (°C/100m)	+2°	+2°
TVA Plume Rise (m)	274	274
Effective Stack Height (m)	2317	2103
Source Strength (gm/sec)	530	530
RESULTS		
Kaiparowits Plateau		
South end, 2310 MSL @40Km	280°	248°
SO_2 (μg/m^3)	23	25
North End, 2200 MSL @19Km	254°	
SO_2 (μg/m^3)	35	
Right Hand Collet, 2150 MSL	175°	
SO_2 (μg/m^3) @12.5Km	46	
Fourmile Bench, 1800 MSL @15Km		148°
SO_2 (μg/m^3)		46
Smoky Mt., 1700 MSL @16Km		260°
SO_2 (μg/m^3)		38

TABLE XVIII

UNSTABLE PREDICTIONS

SULFUR DIOXIDE GROUNDLEVEL CONCENTRATIONS

EQUIVALENT STABILITY CLASS, B

	Fourmile Bench	Nipple Bench
INPUT DATA (3000MW)		
Base Height(m,MSL)	1860	1585
Stack Height (m)	183	244
Winds (m/sec)	5	5
Lapse Rate (°C/100m)	-2°	-2°
TVA Plume Rise (m)	375	375
Effective Stack Height (m)	2418	2204
Source Strength (gm/sec)	530	530
RESULTS		
Wind Direction	90°	135°
Distance (m)	2100	2300
SO_2 (μg/m^3)	65	56

in the inversion layer. Because limited mixing cases are generally produced by subsidence from above, the lapse rate in the inversion layer is not nearly so strong as ground based inversion produced by radiative processes. Although any stability might exist below the inversion, B stability would be a "worst" case approximation. B stability equivalents have been used, therefore, to simulate conditions existing below the inversion. It should be pointed out that the inversion base is not a perfectly reflecting surface but one which allows pollutant diffusion into the stable layer. Again, wind directions were chosen to keep the maximum concentrations on the source Bench since that is the highest terrain involved. The results are shown in Table XIX.

4.4 Inversion Breakup

This atmospheric process is one in which the plume, initially embedded in a stable layer of air, is subsequently mixed to the ground by convective activity which starts at the earth's surface shortly after sunrise. The moment in the fumigation process, which produces the highest groundlevel concentrations, is that when the convective activity reaches just above the stable plume height. In modeling this situation, a stable layer is placed immediately above the stable plume rise. That stable layer was assumed to be equivalent to F stability since very stable situations at plume height would probably be required to trap the plume. The convectively mixed layer is given B stability equivalent diffusion coefficients. With the numerical model, this situation is approached with a steady-state approximation similar to the limited mixing case. This steady-state approximation has been found equivalent to the dynamic time dependent process.[10] Using the numerical model in a transient mode, the inversion breakup if taken in discrete time steps gave similar results to the approximation utilized here. This approach differs substantially from the common Turner Workbook method[2] or that used by NOAA.[3] The primary conceptual difference is that these other methods assume that the plume only spreads 15° in the crosswind direction as it is diffused groundward. If the mixed layer is assumed to have B stability equivalent diffusion coefficients, the plume will be diffused at the much larger rate than 15° allows. Perhaps if the fumigation process were extremely rapid, the assumption might be true, but then the resultant maximum groundlevel concentration would have little effect on a three hour concentration comparable to the ambient standards. If the process is slower, as we propose it is for the 500 meters of effective stack height in this case, then the appropriate diffusion coefficients in the well mixed layer should be allowed to govern the process.

TABLE XIX

LIMITED MIXING PREDICTIONS

SULFUR DIOXIDE GROUNDLEVEL CONCENTRATIONS

EQUIVALENT STABILITY CLASS, B-MIXED LAYER
E-INVERSION LAYER

	Fourmile Bench	Nipple Bench
INPUT DATA (3000 MW)		
Base Height (m,MSL)	1860	1585
Stack Height (m)	183	244
Winds (m/sec)	5	5
Lapse Rate (°C/100m)	-1°/2°	-1°/2°
TVA Plume Rise (m)	274	274
Effective Stack Height (m)	2418	2204
Source Strength	530	530
Inversion Base (m/AGL)	500	520
RESULTS		
Wind Direction	90°	135°
Distance (m)	2100	2300
SO_2 (μg/m^3)	135	120

Two factors may lead to the fumigation predictions overestimating groundlevel concentration. First, it is assumed that the plume rising in a well mixed layer will be stopped by the inversion base placed just above the stable plume rise. It is, however, probable that the plume will penetrate that inversion layer thereby reducing groundlevel concentrations for that inversion base height. Of course, at some higher inversion base height, the plume will not have sufficient thermal excess to penetrate into the stable layer. The second conservatism is the use of B stability in the mixed layer. As alluded to before, the elapsed time of the inversion breakup process is important. Convective activity of the B stability type results in rapid breakup and relatively small time-averaged concentrations. C or D stability in that layer would give reduced maxima, but might be more indicative of the slow breakup which influences three-hour maximum groundlevel concentrations.

The results of the inversion breakup calculations are presented in Table XX. It should be pointed out that here (as well as the unstable and limited mixing cases) the 3000 MW is divided up among 4 discrete 750 MW stacks each separated by 93 meters. At the Fourmile Bench site they are aligned north-south while at the Nipple Bench site they are aligned southwest-northeast. It was found that the highest concentrations at groundlevel occur when the wind is perpendicular to such a line of stacks. The calculation for the parallel wind was made utilizing the increased plume rise expected based on Briggs method.[11]

The results presented were tested for two other assumptions that have been made in the calculations. If, instead of F stability in the inversion layer, diffusion coefficients representative of E stability were used above the inversion base, the maximum groundlevel concentration would have been 225 micrograms per cubic meter. Additionally, if Briggs stable plume rise method were utilized and E stability were maintained in the stable layer, the rise would have been much reduced and the maximum groundlevel concentration would have been 350 micrograms per cubic meter. The TVA plume rise method was used in the predictions because it is most representative of large coal fired power plants.

TABLE XX

FUMIGATION PREDICTIONS

SULFUR DIOXIDE GROUNDLEVEL CONCENTRATIONS

EQUIVALENT STABILITY CLASS, B-MIXED LAYER
F-INVERSION

	Fourmile Bench	Nipple Bench
INPUT DATA (3000 MWe)		
Base Height (m, MSL)	1860	1585
Stack Height (m)	183	244
Winds (m/sec)	3	3
Lapse Rate (°C/100m)	-2°/2°	-2°/2°
TVA Plume Rise (m)	274	274
Effective Stack Height (m)	2317	2103
Source Strength (gm/sec)	530	530
Inversion Base (m,AGL)	490	550
RESULTS		
Wind Direction	90°	135°
Distance (m)	2100	2100
SO_2 (µg/m^3)	255	225

The inversion breakup calculations produced the highest groundlevel concentrations for each site and is, therefore, the "worst" case found in this predictive exercise. The unique consequence of this fact is to tend to favor the Nipple Bench site over the Fourmile Bench site. The 244 meter stacks which are planned for that site provide increased height and, therefore, reduced groundlevel concentrations. Also, Nipple Bench is much smaller. When inversion breakup occurs at Nipple Bench, the chances are much greater that the maximum will be off the bench and will be reduced by the extra height through which the plume must travel.

4.5 Comparison to Ambient Air Quality Standards

The values of groundlevel concentrations predicted in the previous section are probably most representative of one hour averages. The Pasquill-Gifford stability classes are now thought to have a one hour averaging time as an upper limit. Using the INTERA model with diffusion coefficients equivalent to Pasquill-Gifford should also result in one hour values. Additionally, the tracer data which was simulated was calculated as one hour average numbers. Having established the predicted results as one hour averages, a methodology must be found to approximate longer period averages. The National Ambient Air Quality standards are expressed in terms of three hour, twenty-four hour, and annual averages as shown in Table XXI.

If the basic wind direction were to remain the same through a three hour period as we have assumed has occured during a one hour period, a ratio between the two averaging times could be developed which accounts for the normal variability of the wind. Hino has presented such a ratio based on the -1/2 power of the time ratio.[12] The ratio of three hour to one hour concentrations would, therefore, be 0.58. For the fumigation predictions at 3000 MW of power plant capacity, this would mean a three-hour maximum at Fourmile Bench of 150 micrograms per cubic meter. At Nipple Bench the three hour maximum would be 130 micrograms per cubic meter. Although other average ratio methods are available, INTERA has found the Hino method most accurate for fumigation situations.[10] For non-fumigation conditions, the peak-to-mean conversion factor developed by the TVA was used to arrive at a three-hour concentration. The conversion value selected was 0.75.

Another possible method of constructing a three hour concentration is to assume one hour of inversion breakup followed by two hours of limited mixing. This essentially provides for the case where a strong radiative surface-based inversion occurs simultaneous

TABLE XXI

NATIONAL AMBIENT AIR QUALITY STANDARDS

SULFUR DIOXIDE IN MICROGRAMS PER CUBIC METER

Primary	Annual	80
	Twenty-four Hour	365
Secondary	Three Hour	1300

to a subsidence inversion at 500 meters. The surface inversion breaks up through 500 meters where the subsidence inversion takes over the trapping process. The result would be a three hour average of 175 micrograms per cubic meter at Fourmile Bench and 155 micrograms per cubic meter at Nipple Bench. These predictions are slightly higher than the inversion breakup method outlined above and should be compared to the three hour standard.

In evaluating twenty-four hour average concentrations, a diurnal pattern of stability situations is constructed. This is thought to be more realistic than any ratio method since the averaging theory loses its validity with changes in stability. A diurnal pattern is hypothesized in which the wind direction and speed are consistent; but there are 17 hours of stable, six hours of limited mixing and one hour of fumigation. Over such long periods of time, the variability of the wind ought to be accounted for. A sector average over 22.5° was utilized (see section 2.5). With winds from the west (270°), 2100 meters downwind from the Fourmile Bench site a maximum twenty-four hour concentration of 43 micrograms per cubic meter is predicted. With winds from the southeast (135°), 2300 meters downwind from the Nipple Bench site, a maximum twenty-four concentration of 39 micrograms per cubic meter is predicted. Other sites downwind would have smaller twenty-four hour concentrations and other wind directions have smaller maxima from which to start the calculations.

Providing an estimate of annual average concentrations is even more problematical. The climatological information available from temperature profile measurements indicate that the atmospheric stability is neutral 50% of the time and stable the remaining time. Estimates were made at each site for both wind direction where the maximum occurs and the most persistent wind direction, 270°. The approximations are presented in Table XXII. All the windspeeds in the specified direction were lumped together although obviously the concentrations change with windspeed as well. An annual power load factor of 75% and an average coal sulfur content of 0.54% was used rather than the maximum value of 0.80% used elsewhere. The combination of neutral and stable (Table XVII) values ignores the fumigation and unstable cases. Since stable layers all the way through plume height are rarely found, it is expected that the incidents of fumigation are quite rare. Unstable situations are probably quite common if the results during the tracer study period are indicative. Low windspeeds occur a maximum of 7.3% of

TABLE XXII

APPROXIMATE ANNUAL AVERAGE CONCENTRATIONS

SULFUR DIOXIDE IN MICROGRAMS PER CUBIC METER

	Neutral & Stable Averages	% Frequency	Annual Average
Fourmile Bench			
Winds 175°	25	8.5	2
Winds 270°	16	13.8	2
Nipple Bench			
Winds 148°	24	3.8	1
Winds 270°	21	13.8	3

the time from the south-southwest. If eight hours of each day were potentially unstable, then one-third times 7.3% yields a potential frequency of 2.4%. At both sites, annual values from these unstable conditions (see Table XVIII) would be maximums of 1 micrograms per cubic meter.

4.6 Site Capacity

Having projected a "worst" case for either of the proposed Kaiparowits plant sites, a maximum site capacity can be calculated. It is expected that if further megawatt output were required from the Kaiparowits site that units of 3000 MW each would be added to the sites. The second such unit would be built at right angles to the first 3000 MW unit and start opposite the northernmost of the first four stacks and proceed westward. The addition of two additional units, a total of 12000 MW site capacity, it is assumed would be built by completing the square started above. These patterns are probably the most compact foreseeable and would represent the highest groundlevel concentrations expected at each MW loading.

The results of the site capacity calculations are given in Table XIII. The wind direction producing the highest concentration has been presented. Twenty-four hour values for 12000 MW calculated as before would produce maximum averages of 150 micrograms per cubic meter at Fourmile Bench and 135 micrograms per cubic meter at Nipple Bench. On an annual basis, the expected maximum rises to 5 micrograms per cubic meter at either site.

It would appear that much more than 12000 MW, perhaps twice that capacity, could be built at either site without significant danger of exceeding ambient air quality standards. Prior to extrapolating predictions beyond 12000 MW more meteorological data and perhaps monitored data of an operational power plant should be available.

TABLE XXIII

SITE CAPACITY PREDICTIONS

Megawatt Capacity	Maximum Emissions SO_2 (gm/sec)	MAXIMUM GROUNDLEVEL CONCENTRATIONS Micrograms per cubic meter 1 Hour	3 Hour	24 Hour
Fourmile Bench				
3000	530	255	175	43
6000	1060	455	306	80
12000	2120	860	579	150
Nipple Bench				
3000	530	225	160	39
6000	1060	400	280	70
12000	2120	760	529	135

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APPENDIX III-4

Air Quality

Summary

Comparison of Several Air Pollutant Dispersion Models with Data in Complex Terrain

APPENDIX III-4

Comparison of Several Air Pollutant Dispersion Models with Data in Complex Terrain

A summary of a diffusion model study performed by Intera Environmental Consultants Ltd. was submitted to BLM in November 1975. The study compared the NOAA Model, the EPA Model (C7M3D) and the Intera/Intercomp Model using data from the Navajo Generating Station Study (Rockwell International 1975), the Huntington Canyon Study (Start, et al, 1974), and the Garfield Smelter Study (Start, et al, 1974).

Intera made the following conclusion from the study:

1. Navajo Generating Station Sulfur Dioxide Study

   For stable cases (Pasquill E and F)

   a. The agreement of the Intera Model with the measured results on elevated terrain surrounding the Navajo Generating Station appears to be well within a factor of two (range 0.6 to 1.25).

   b. The Gaussian NOAA Model overestimated ground level concentrations on the Vermillion Cliffs by a factor of 3 to 15.

   c. The EPA Gaussian Model (C7M3D) is in much better agreement with the measured results. Used with F stability it apparently overestimates by roughly a factor of two and one-half (range 0.7 to 2.7).

2. Garfield Utah Smelter Study

   For unstable cases (Pasquill B and C)

   a. The Intera Model estimated aerial plume centerline concentrations within a factor of two and estimated ground level concentrations within a factor of two and a half (range 0.45 to 2.5) and accurately estimated the position of the maximum and the pattern of concentration isopleths.

   b. The ratio of calculated to observed concentrations for the NOAA Model was 0.26 to 1.5.

   c. The ratio of calculated to observed concentrations for the EPA Model was 0.15 to 1.4.

3. Huntington Canyon Validation Study

   For stability cases B, D, and F

   a. The ratio of calculated concentrations to observed concentrations for the Intera Model ranged between 0.41 to 2.30.

b. The ratio of calculated concentrations to observed concentrations for the Gaussian Models ranged between 1.4 and 18.9.

Intera concluded that the Intera/Intercomp Model results in rough terrain were equivalent to Gaussian Model results in flat terrain, that is, within a factor of two.

It should be noted that EPA did not completely agree with Intera's interpretation of the Huntington Canyon Study. EPA felt that if modeling results were to be used directly in source-control decisions, a reliable model must represent the near-upper envelope of observable concentrations.

APPENDIX III - 5

Estimated Post Combustion Concentration of Trace Elements in Bottom Ash and Fly Ash

FIGURE 1

Air Quality

Kaiparowits Plateau impact area

Estimated Post Combustion Concentration of Trace Elements in Bottom Ash and Fly Ash

	Analysis in Coal or ash (ppm)		Fractionation				Precipitator Capture	Release From Stack ^{c}	
			Bottom Ash		Fly Ash				
Element	Coal	Ash^{b}	ppm	lbs/day	ppm	lbs/day	lbs/day	lbs/day	
Antimony	.13 ± .07^{b}		0	0	1.8	9	8.9	0.1	
Arsenic	.83± .81^{a} .90± .20^{b}		0	0	8.8	43	42	14	Assumes a 25% fractional release to the atmosphere as vapor (Williams and Walther 1974)
Barium		2290± 2055	2290	2800	2290	11144	11088	56	
Beryllium	.48± .19^{a}	3.40± 3.30	4	5	4	20	19.9	0.1	
Boron		1400± 834	1400	1680	1400	6686	6653	33	
Cadmium	.87± .73		9	11	9	46	45.8	0.2	
Cerium	Not detected								
Chromium	3.6 ± 2.3^{a}	62± 11	0	0	61	298	296	2	
Cobalt		12± 10	12	15	12	58	57.7	0.3	
Copper		80± 11	0	0	98	478	472	2	
Fluorine	54 ± 42^{a}	120± 23	0	0	594	2900	2886	2914	Assumes a 50% fractional release to atmosphere as gas (Williams and Walther 1974)
Gallium		26± 5	0	0	32	155	154	1	
Germanium	Below limits of detection								
Lanthanium	Below limits of detection								
Lead		38± 11	0	0	47	227	226	1	
Lithium		72± 26	72	88	72	353	351	2	
Manganese	6± 2^{a}	210±164		166	136	661	658	3	
Mercury	.06±.07 .04±.01		0	0	.002	.01	0	4	Assumes a 96% fractional release to the atmosphere as vapor (Southwest Energy Study 1972 Williams and Walther 1974)
Molybdenum		6± 3	0	0	7	36	35.8	0.2	
Nickel	5± 1^{a}	34± 21	0	0	55	269	268	1	
Selenium	4± 4 1.98± .58		0	0	31	150	149	50	Assumes a 25% fractional release to atmosphere as vapor (Williams and Walther 1974)
Strontium		560± 261	560	683	560	2719	2705	14	
Scandium		14± 2	14	17	14	68	67.7	0.3	
Tellurium	Below limits of detection								
Thallium		.34± .12	.34	.41	.34	1.66	1.65	.01	
Titanium		3000± 1	3000	3660	3000	14567	14494	73	
Uranium	.66± .36^{b}		7	9	7	35	34.8	0.2	
Vanadium	8± 1	92± 35	0	0	111	537	534	3	
Yitrium		44± 24	44	54	44	215	214	1	
Ytterbium		4± 1	4	5	4	19	18.9	.1	
Zinc		64± 70	0	0	78	382	380	2	
Zirconium		150± 1	150	183	150	732	728	4	

[a] Data from report to Arizona Public Service and Southern California Resource Data 1974.

[b] Data from Southwest Energy Study, Appendix J., U.S. Bureau of Geological Survey January 1972.

[c] **Assumes no removal of elements by sulfur dioxide scrubbing system.**

Calculations based on worst grade coal, 0.80 percent sulfur, 10 percent ash content, 10,600 Btu, 33,600 tons/day burned.

APPENDIX III-6

Air Quality
Estimated Emissions of Radioactive Nuclides

APPENDIX III-6

EMISSIONS OF RADIONUCLIDES FROM

KPOO @ 3000 M.W.

I. Particulate Emission Rates

Worst grade coal (9 percent ash) 0.58 ton/h

II. Radioactivity

Radionuclide	Coal Concentration (pCi/g)	Ash Concentration (pCi/g)
Radium - 226	0.13	1.44
Radium - 228	0.18	2.00
Thorium - 230	0.20	2.22
Thorium - 232	0.17	1.89
	0.68	7.55

III. Stack Gas Radioactivity Calculated

Stack gas flow rate = 2.4×10^6 acfm - per unit

= 9.6×10^6 acfm - total

Average grade coal

13.92 T/d x 2000 lbs/ton = 27840 pounds/day

27840 pounds/day x 453.59 g/lb ÷ 1440 min/day

= 8769 gm/min fly ash emitted

Ra-226

1.44 pCi/g x 8769 g/min = 12628 pCi/min

Ra-228

2.00 pCi/g x 8769 g/min = 17539 pCi/min

Th-230

2.22 pCi/g x 8769 g/min = 19468 pCi/min

Th-232

1.89 pCi/g x 8769 g/min = 16574 pCi/min

Dividing these results by the stack gas emission rate yields the following activity concentrations in the undispersed stack gas

Ra-226

12628 pCi/min ÷ 9.6 x 10^6 acfm = 0.00132 pCi/ft^3

Ra-228

17539 pCi/min ÷ 9.6 x 10^6 acfm = 0.00183 pCi/ft^3

Th-230

19468 pCi/min ÷ 9.6 x 10^6 acfm = 0.00203 pCi/ft^3

Th-232

16574 pCi/min ÷ 9.6 x 10^6 acfm = 0.00173 pCi/ft^3

Conversion to pCi/cubic meter yields the following radioactivity in the stack gas before atmospheric dispersion:

Ra-226

0.00132 pCi/ft^3 x 35.31 ft^3/m^3 = 0.047 pCi/m^3

Ra-228

0.00183 pCi/ft^3 x 35.31 ft^3/m^3 = 0.065 pCi/m^3

Th-232

0.00203 pCi/ft^3 x 35.31 ft^3/m^3 = 0.072 pCi/m^3

Th-230

0.00173 pCi/ft^3 x 35.31 ft^3/m^3 = $\underline{0.061\ \text{pCi/m}^3}$

$0.257\ \text{pCi/m}^3$

IV. Regulations

Maximum permissable concentrations (MPC) of radionuclides in air have been set by the AEC (10CFR Part 20) as well as by the U.S. Department of Commerce, National Bureau of Standards (Handbook 69). Occupational MPC is divided by 10 to obtain non-occupational MPC, which in turn is divided by 3 to get the general public exposure MPC. For purposes of this analysis, the lowest MPC (insoluble) will be used. (Table 2, Appendix AEC 10 CFR Part 20).

(insoluble) Radionuclides	mCi/ml	pCi/m^3	General Public Exposure pCi/m^3
Ra -226	2×10^{-12}	2	0.067
Ra -228	1×10^{-12}	1	0.033
Th -228	2×10^{-13}	0.2	0.0067
Th -232	1×10^{-12}	1	0.033
Th -230	3×10^{-13}	0.3	0.01

Calculation of effective concentrations of known mixtures of radionuclides is accomplished by the following:

$$\Sigma\, i \left[\frac{\text{calculated concentration}}{MPC_i}\right] \quad i \quad = \quad <1$$

Using the relationship, and applying the computed activity levels of stack gas radionuclides at the stack exit.

Nuclide	Ra -226	Ra -228	Th -230	Th -232	
Ratio	$\frac{0.047}{0.067}$	$\frac{0.065}{0.033}$	$\frac{0.072}{0.010}$	$\frac{0.061}{0.033}$	
Sum	0.070	+ 1.97	+ 7.2	+ 1.85	= 11.72

As the gas is emitted from the stack, it exceeds the MPC in air for the general population. A dilution factor of at least 10.0 would be required to reduce the ground level concentration to a value which would meet the MPC standard for the general population of less than 1.0

Based on the dispersion calculations for the primary nuclides, the flue gases could be expected to be diluted by factors in the range of 1,000 to 2,000 or greater. Assuming a dilution factor of 1,000, the following is obtained:

$$\frac{0.000047}{0.067} \quad + \quad \frac{0.000065}{0.033} \quad + \quad \frac{0.000072}{0.010} \quad + \quad \frac{0.000061}{0.033}$$

$$0.0007 \quad + \quad 0.0020 \quad + \quad 0.0072 \quad + \quad 0.0018 \quad = \quad 0.01$$

With an assumed dilution rate of 1,000, the MPC level is a factor of 100 below the allowable maximum.

APPENDIX III - 7

Air Quality

Visibility Study

APPENDIX III - 7

Air Quality

Kaiparowits Plateau impact area

Visibility study

Stack emissions can include soot and fly ash as well as particles formed by catalyzed or photochemical reactions in the atmosphere. For coal burning power plants, the important reactions are conversion of sulfur dioxide to sulfates and nitrogen oxides to nitrates.

Size distribution is one of the main properties of these aerosols affecting visibility, although aerosol concentration and physical characteristics are also involved. Investigators have determined that 90 percent of visibility reduction is caused by particles in the 0.1 to 1.0 micron (um) range (USDAEW, 1969; Charlson, 1969; Corn, 1968; Shannon, 1971; Faith and Atkieson, 1972; Rich, 1971).

Hill and other investigators have shown that a significant contribution to light scattering by fly ash, soot, and ammonium sulfate-nitrate particles is made by particles up to 2-5 um and by soil dust particles up to 5-8 um (Hill et al., 1973a; Hill et al., 1973b).

The size effect is primarily due to scattering of light, reducing object contrast ultimately to a point where the object can no longer be distinguished from its background. Relative humidity can also play a crucial role in visibility affected by particles, particularly at relative humidities above 70 percent.

Chemical composition of particulates affect their refractive index and light absorption properties but these properties are of secondary importance to visibility reduction from light scattering.

In the following study, Bechtel Power Corporation (1974) concluded that in the Kaiparowits region, sulfur dioxide is not expected to have a direct effect on visibility; however, conversion of sulfur dioxide to particulates will have an impact. In addition, the degree of brown discoloration in the plume will be proportional to the concentration of NO_2.

Effect of sulfur oxides on visibility

Sulfur dioxide (SO_2) is a colorless gas and does not directly affect visibility. SO_2 can however, be oxidized to sulfur trioxide (SO_3) which can then combine with atmospheric water to form a sulfuric acid mist. Johnstone and Coughanour (1958) have shown that SO_2 is oxidized slowly in the gas phase in the atmosphere but after absorption on liquid droplets it will react much more rapidly. Some sulfur trioxide (about one to five percent of total sulfur) usually accompanies sulfur dioxide in flue gases. Additional SO_3 is produced in the stack plume in two other ways. The first is a catalyzed reaction that is dominant for relative humidity above approximately 90 percent; and dependent upon SO_2 concentration. The reaction rate decreases very rapidly as the plume is diluted (Wayne, 1973). The second reaction is a photochemical process and appears to be independent of concentration or humidity.

Combining of SO_3 with other materials such as water and ammonia to form sulfate particles, and with water to form sulfuric acid mist, add to the aerosol mass concentration of the atmosphere which in turn has a potential effect on visibility. The important factors affecting the conversion rate are relative humidity, concentration of catalytic metals, intensity of sunlight, plume altitude and sulfur dioxide concentration. From an assessment of these factors, as they apply to emission from the proposed Kaiparowits plant and meteorological conditions in the area surrounding the proposed site, Bechtel estimated that four percent of the sulfur dioxide leaving the plant would be converted to sulfate (Bechtel 1974). The four percent conversion rate is based on the assumption of a 90 percent relative humidity condition that occurs less than 20 percent of the time at the site.

For relative humidity less than 90 percent, the sulfate conversion rate would be less than four percent.

Predictions of impact on visibility

The relationship between visibility and aerosol mass concentration can be approximated by the equation (Charlson 1969):

$$LV = \frac{1120}{C}$$

Where: LV = Local Visual range

LV can be interpreted as standard visual range when the aerosol concentration is homogeneous along the observer's line of sight.

C = aerosol mass concentration

Using this relationship, Bechtel Corporation used derivations of a mathematical model (Turner, 1970) to explore several different lines of sight relative to the plume and determine the concentration of aerosols along those lines and resulting visual ranges. Visual range was defined as the distance the apparent contrast of an object is reduced to two percent of its inherent value. Lines of sight considered were at ground level under the centerline of the plume both toward and away from the plant and perpendicular to the plume at different distances down-wind from the plant.

The following assumptions were made:

1. Gaussian plume dispersion.
2. Four percent of releasedd SO_2 immediately converted to aerosols.
3. Negligible conversion of NO_X to aerosols.
4. A background aerosol concentration yielding an average visual range of 70 miles.
5. Neutral meteorological conditions.
6. Unidirectional wind speed of 2.5 meters per second (5.6 mph).
7. LV = 1120/C

The study concluded that it would be necessary for an observer to look directly along the plume centerline in the direction of the station before any visibility reduction would occur. Visibility reductions in these cases were approximately 10 to 20 miles,, (Illustrations 1 and 2). Visibility reduction from other lines of sight was insignificant. Conclusions were based on assumed meteorological conditions (high humidity, wind, and stability persisting for several hours) which were estimated to have a simultaneous occurrence probability of approximately five percent.

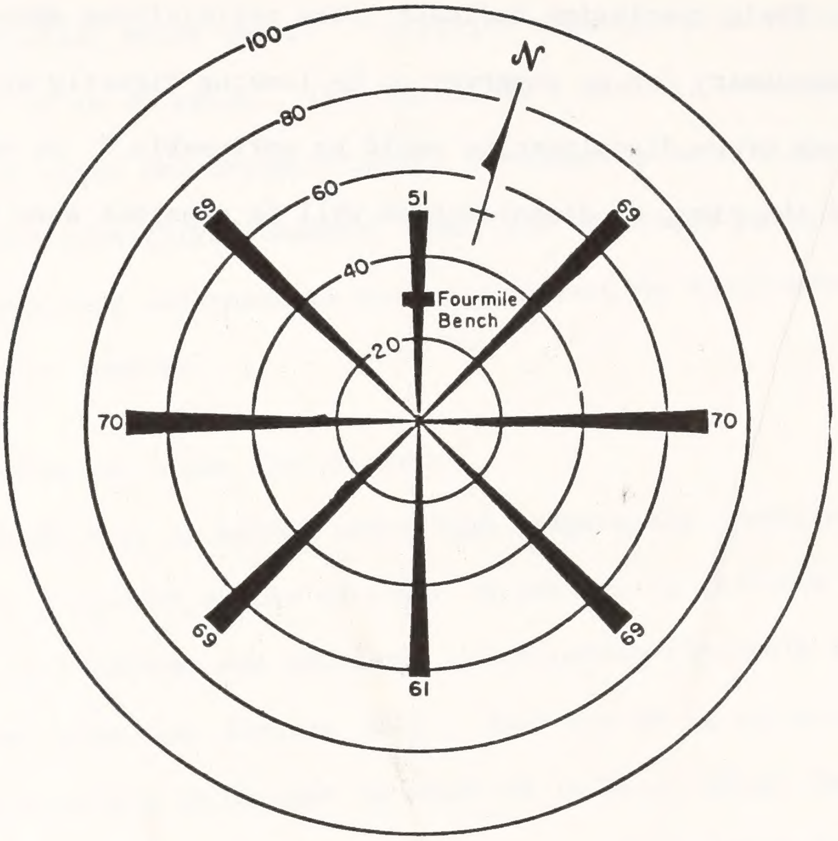
Nitrogen dioxide and brown discoloration

When fossil fuel is burned under high temperature conditions with air as an oxidant, a portion of the nitrogen in the air is oxidized to nitric oxide (NO) which is colorless and odorless. A comparatively small amount (about 5.0 percent) becomes nitrogen dioxide (NO_2). When the NO is released to the ambient air, approximately 10 percent is oxidized to NO_2. After the concentration of NO reaches one ppm in the atmosphere, a photochemical reaction takes place that is dependent on sunlight, ozone, hydrocarbons, and the total concentration of NO. The production rate of NO_2 is reduced by atmospheric dilution of NO below one ppm, and by the absence of ozone or hydrocarbons.

It is possible that NO_2 can be further oxidized to N_2O_5, which with water vapor forms nitric acid (HNO_3). This, in turn, reacts with various metal salts yielding a particulate phase, metal nitrate (Faith and Atckinson, 1972). Wayne (1973) believes this process to be negligible at Kaiparowits.

Nitrogen dioxide remaining in the atmosphere absorbs bluegreen light, giving the atmosphere a yellow-brown discoloration proportional to the NO_2 concentrations. The rate of NO_2 production by a fossil fuel burning power plant and its rate of production in the atmosphere downwind of the power plant are not well known. Brown discoloration does, however, have the potential for degradation of visual environment.

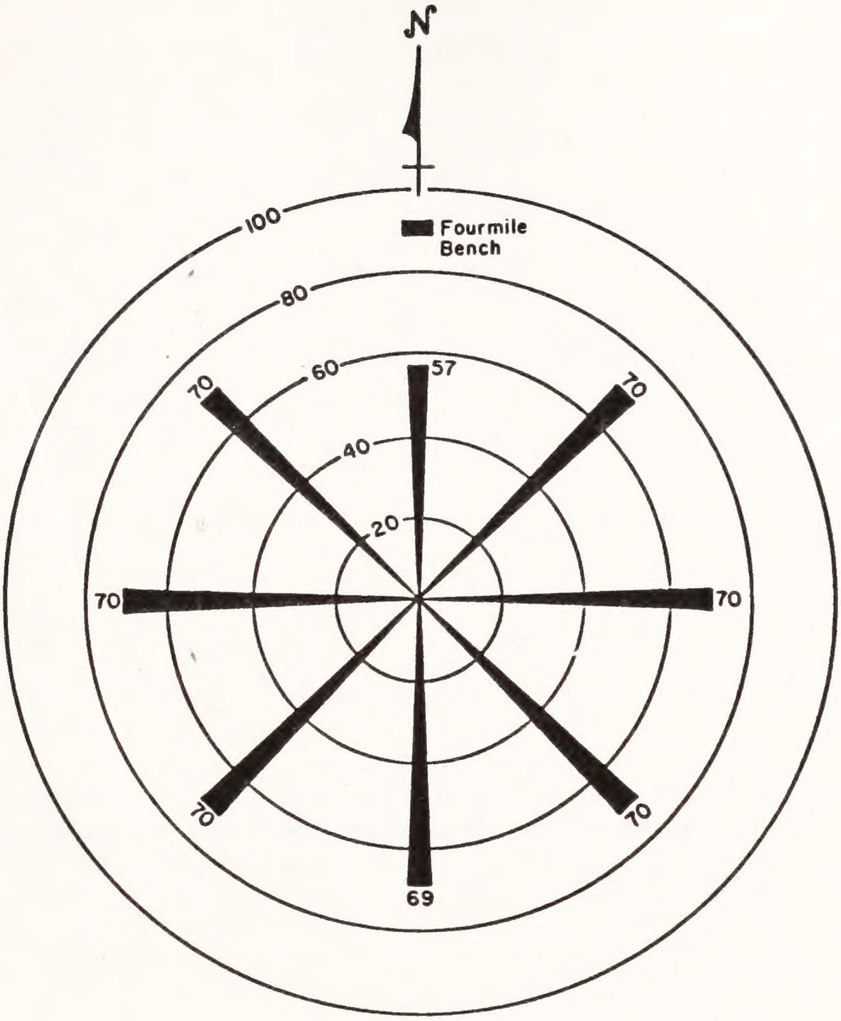
An estimate of the effect of nitrogen dioxide on atmospheric discoloration was made by Bechtel Corporation using a variation of the visibility calculation. Their conclusion indicate, "the calculations showed that usually it would be necessary for an observer to be looking directly along the plume axis before any brown discoloration would be noticeable." It was further stated that "most of the time, no discoloration will be apparent when looking across the plume."



This illustration assumes that an observer is in the center of the rose (Page, Arizona) with the plume from a plant at Fourmile Bench overhead. Looking north toward Fourmile Bench, the visual range would be reduced from 69 miles to 51 miles. Looking south the visual range would be reduced from 69 miles to 61 miles.

ILLUSTRATION 1

Visual Rose at Page, Arizona With Plant at Fourmile Bench
70 Mile Background Visual Range
(Frequency of Occurrence Less Than 5 Percent)



This illustration assumes that an observer is in the center of the rose (Grand Canyon) with the plume from a plant at Fourmile Bench overhead. Looking north toward Fourmile Bench, the visual range would be reduced from 70 miles to 57 miles. Looking south the visual range would be reduced from 70 miles to 69 miles.

ILLUSTRATION 2

Visual Rose at Grand Canyon With Plant at Fourmile Bench
70 Mile Background Visual Range
(Frequency of Occurrence Less Than 5 Percent)

APPENDIX III-8

Air Quality and Noise Impact Study for the Access Roads to Kaiparowits (Studies by the Utah Department of Transportation)

APPENDIX III-8

AIR QUALITY FOR THE ACCESS ROADS TO KAIPAROWITS

An evaluation of the impact of the proposed highway on air quality was made on two scales: mesoscale and microscale. Mesoscale refers to the region affected by traffic changes brought about by the proposed project. Microscale refers to the roadway vicinity where concentrations of pollutants contribute noticeably to background pollutant levels.

The primary pollutants emitted from motor vehicles are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x) and particulates. Estimates of CO, HC and NO_x are made in the mesoscale (over the total length of the facility); only CO is estimated in the microscale because of its inertness and model availability.

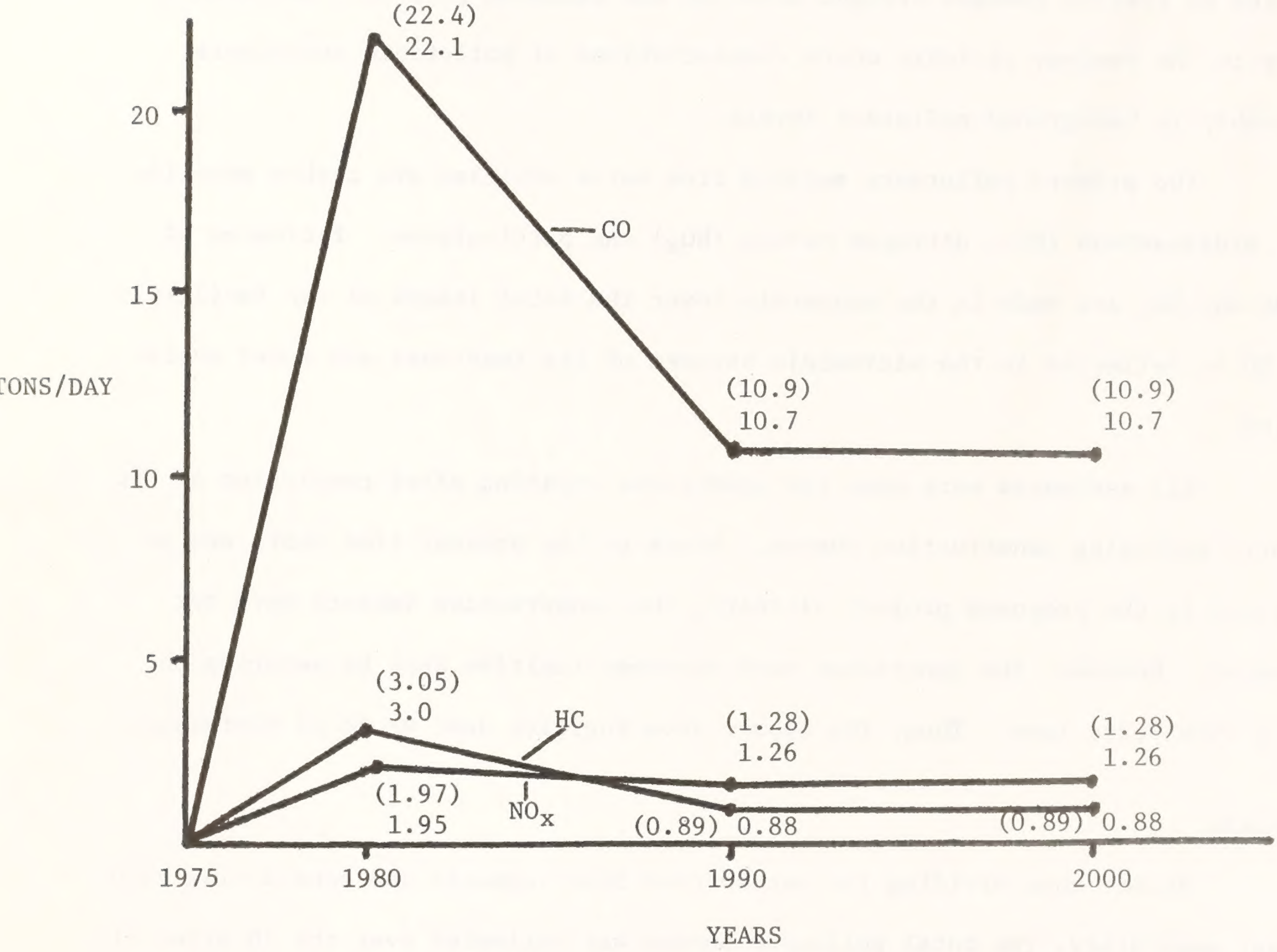
All estimates were made for conditions existing after completion of the project, excluding construction phases. Since at the present time there are no receptors in the proposed project vicinity, the construction impacts were not estimated. However, the contractor must suppress fugitive dust by watering to comply with State laws. Thus, the impact from fugitive dust would be minimized.

Mesoscale

Rather than dividing the access road into segments and considering each segment separately, the total pollutant burden was estimated over the 70 miles of roadway to be constructed, using the highest traffic projections in any given segment. Estimates of CO, HC and NO_x were made for 1980, 1990 and the year 2000 using high altitude emission factors, and 10 percent truck traffic.

Assuming project completion in 1980, estimates indicate that maximum CO, HC, and NO_x emissions would take place after the opening of the road; they will start dropping by the year 1990 and from then on remain relatively constant.

The assumption is made that no expansion of the power plant would occur and traffic would remain essentially the same. However, if traffic increases, emissions would increase accordingly. The decline in emissions would be mostly due to installation of emission control devices on new vehicles.



Total pollutant emissions over the entire length of the road, with and without attracted traffic from US-89. (Numbers in parentheses indicate total emissions with attracted traffic.)

Microscale

CO concentrations in the microscale were estimated at the town sites, assuming the road would go through the town. If the main road were located outside the town limits, the CO impact would be even smaller.

Under the worst meteorological conditions (inversions, winds of 1 meter per second at an angle of 22.5 degrees to the roadway) and peak traffic (shift changes), CO concentrations are estimated to be 3.1 ppm 10 meters from the roadway. As distance from the roadway increases, CO concentrations decrease rapidly reaching background levels (0.2 ppm) at approximately 50 meters from the roadway. With a wind angle of 13 degrees to the roadway, CO concentrations at 10 meters are estimated to be 5 ppm and 0.2 ppm at 50 meters. All estimates are above background levels. Future CO concentrations could be less than 1 ppm at 10 and 50 meters from the roadway if emission control devices are installed in new vehicles and traffic does not increase significantly.

Since the "worst possible case" indicates that traffic-contributed CO concentrations are relatively small and considerably below the 1-hour National Standard (35 ppm), the "most probable" case would be much lower and therefore, it was not considered.

Eight-hour averages would probably be below the National Standards of 9 ppm, since the maximum 1-hour estimate is only 5 ppm.

If the road was not built, existing pollutants would remain at background levels which are probably quite small.

Background

The entire 70-mile length of the two-lane road would provide access to the proposed plant, mine site and town site. Traffic projections used in the evaluation were provided by the Office of Policy and Systems Planning of the Utah Department of Transportation. The highest average daily traffic projected to use any section of the facility after it is completed is estimated at 6,600 vehicles, with a maximum of 10 percent being trucks. Because of the steep grades along the road, it is doubtful that commercial truck drivers would use this road as a short cut. The only anticipated truck traffic would be trucks from the proposed mine to the plant site and from the plant site to the ash and sludge disposal sites.

Traffic

An analysis of traffic on US-89 shows that the present average daily traffic is 835 vehicles with 15 percent trucks and 50 percent out-of-state vehicles. If some of this traffic were to use the proposed new highway as a short cut, it would probably be automobiles rather than trucks. It is difficult to predict the amount of traffic that would be attracted by the proposed new highway. In order to be relatively safe, it was assumed that 10 percent of the traffic using US-89 would use the new highway, raising the average daily traffic to almost 6,700 vehicles.

Peak hourly traffic is expected to occur during shift changes; there are three shifts planned at the present time. Since almost all traffic on the proposed new highway would be to and from the plant and the mines, it is reasonable to assume that peak traffic would most likely be one-third of the average daily traffic (2,200 vehicles). Local and through traffic would have a negligible impact.

For the mesoscale, speeds were assumed to be an average of 40 mph. For the microscale, they were estimated at 25 mph (through town or city limits).

Model

The mathematical model used for the microscale analysis is based on the Gausian Diffusion Equation relating traffic, emission factors, meteorology and highway design with the output of CO concentrations in parts-per-million (ppm) downwind from the highway.

The emission factors (grams per mile) are based on the latest EPA procedures for calculating emissions from motor vehicles at high altitudes.

Estimates of Access Highway Emissions by Years

Emission	1980 (gm/mi)		1990 (gm/mi)		2000 (gm/mi)	
	25 mi/h	40 mi/h	25 mi/h	40 mi/h	25 mi/h	40 mi/h
Carbon Monoxide	57	43.50	26.52	21.15	26.52	21.15
Hydrocarbons	-	5.92	-	1.74	-	1.74
Nitrogen Oxides	-	3.83	-	2.48	-	2.48

Meteorology

Because of the topographic effects, the meteorological conditions here are rather unique. Data on wind speeds and direction, precipitation, humidity, etc. were gathered at Nipple Bench and Fourmile Bench but not at Clark Bench.

If Clark Bench were chosen as the town site and Nipple Bench as the plant site, the pollutants emitted from the plants would not have any effects on the town site because of the distance between, the rugged terrain, and elevation difference. If the plant were built at Fourmile Bench, the distance between the plant and the town site would be even larger and the effects would be even smaller.

The only significant source of pollutants in the vicinity is the Navajo Power Plant in Page, Arizona, about 25 miles from the proposed town site.

Summary

Overall, the construction of the road would not bring about significant impacts to the air quality in the vicinity.

Although the total CO emissions on a daily basis seem large (22 tons per day), the fact that they are spread over the entire 70 miles of highway minimizes the impact.

The microscale effects would be rather small (1 to 5 ppm at 10 meters from the roadway).

Compliance of the project with the State Implementation Plan is shown in the attached letter from the Utah Bureau of Environmental Health.

KAIPAROWITS NOISE ASSESSMENT
(Revised 12-26-75: by John Neil)

New Town Sites

Using a conservative approach (favoring the residents) and based upon the NCHRP-117 noise prediction model, the following table shows the maximum distance from the centerline of the proposed road that residences of a new town site should be in order to not exceed the Federal Highway Administration's FHPM 7-7-3 (PPM 90-2) design noise levels (L_{10} or Level exceeded ten percent of the time, in decibels, dBA).

Option	Worst Case (70 dBA)	Probable Maximum Outdoor (70 dBA)	Probable Maximum Indoor (55 dBA)
A-1	350'	170'	370'
A-2	260'	150'	320'
A-3	60'	50'	110'
A-4	40'	40'	90'
B	300'	150'	320'

Option Description:

A-1 = Through town, 25 mph, All vehicles allowed

A-2 = Through town, 40 mph, All vehicles allowed

A-3 = Through town, 25 mph, No diesel trucks

A-4 = Through town, 25 mph, No trucks over 10,000# GVW

B = Outside town, 50 mph, All vehicles allowed

Worst Case = 2200 vph, 10% trucks (of which half are assumed to be diesel powered)

Probable Maximum = using one-fourth as many trucks, since truck mix ratio would be lower during commuter hours.

Existing Communities

Noise generated by diesel-powered trucks - that are to haul limestone through Tropic and Cannonville - will be annoying to those living close to the path of the trucks. Even though the near-peak noise (L_{10}) level for a continuous span of time will fall well below the Federal Highway Administration's design levels, the peak noise of individual passing trucks (one approximately every fifteen minutes) will probably average about 86 dBA at 50 feet and exceed 91 dBA during five percent of the individual passes (equivalent to a brief exposure to an operator of a power lawn mower or food blender on high speed). Communication at those brief instants will be nearly impossible. As far back as 200 feet from the roadway, the low frequency noise from heavy trucks will easily penetrate wood frame homes (even in cold weather when windows are closed). It can be expected that baby's nap time, television listening and other sound sensitive activities of the daytime and evening could, in some cases, be disturbed.

On a less gloomy note, although traffic noise is often regarded as loud by nearby residents and, in some cases, annoying, traffic noise may usually be disregarded as a source of hearing loss. Very noisy trucks and motorcycles are too infrequent to maintain a sufficiently high noise level to cause hearing damage. As for the degree of annoyance, it will depend upon the amount of background noise and the nature of the working or living activity of the people at the time the noise is heard. Thus, the degree of annoyance is very relative, ranging from almost no awareness at all to disruption of thought and communication processes.

Doing something about the noise is not simply a matter of designing and/or building a truck route away from a community. It will be more of a tradeoff between noise and other considerations, such as economics, aesthetics, community preference and safety.

Little help can be expected in the way of manufacturing significantly quieter trucks.

Recommendations

New residential developments should be kept at least 400 feet away from the truck routes in order to satisfy Federal Highway Administration's noise standards. A special truck route could be planned to bypass the residential neighborhoods of the existing communities of Tropic and Cannonville. Whether by truck rerouting or some other scheme, keeping truck noise away from residents would be a concern not to be taken lightly.

CALVIN L. RAMPTON
Governor

PAUL S. ROSE
Executive Director

1896

STATE OF UTAH–DEPARTMENT OF SOCIAL SERVICES

DIVISION OF HEALTH
44 MEDICAL DRIVE
SALT LAKE CITY, UTAH 84113
AREA CODE 801

Board of Health
Air Conservation Committee
Health Facilities Council
Medical Examiner Committee
Nursing Home Advisory Counc
Water Pollution Committee

LYMAN J. OLSEN, M.D., M.P.H.
Director of Health

533-6108

BUREAU OF ENVIRONMENTAL HEAL
72 East 4th South
Salt Lake City, Utah

November 28, 1975

Mrs. Catherine V. Chachas
Environmental Engineer
Utah Department of Transportation
Room 400
State Office Building
Salt Lake City, Utah

Dear Mrs. Chachas:

The air quality evaluation for the proposed access roads to Kaiparowits has been reviewed and evaluated.

Since the roads will be located outside carbon monoxide strategy areas and since the ambient concentrations are predicted to be well below the ambient standards, the proposals are consistent with the Utah Implementation Plan.

Sincerely,

Alvin E. Rickers

Alvin E. Rickers
Assistant Director
Bureau of Air Quality

RLR:bw

APPENDIX III - 9

Impacts of Proposed Action on Soils

APPENDIX III - 9

Soils

Kaiparowits Plateau Impact Area

Impacts of proposed actions on soils

Introduction

All data developed to identify the various effects of power plant construction, mine construction and road construction are contained in this section. A brief explanation is given for each table and figure, describing methods used for their development. A summary of the effects are given in the main report in Chapter III, Impacts on Soil.

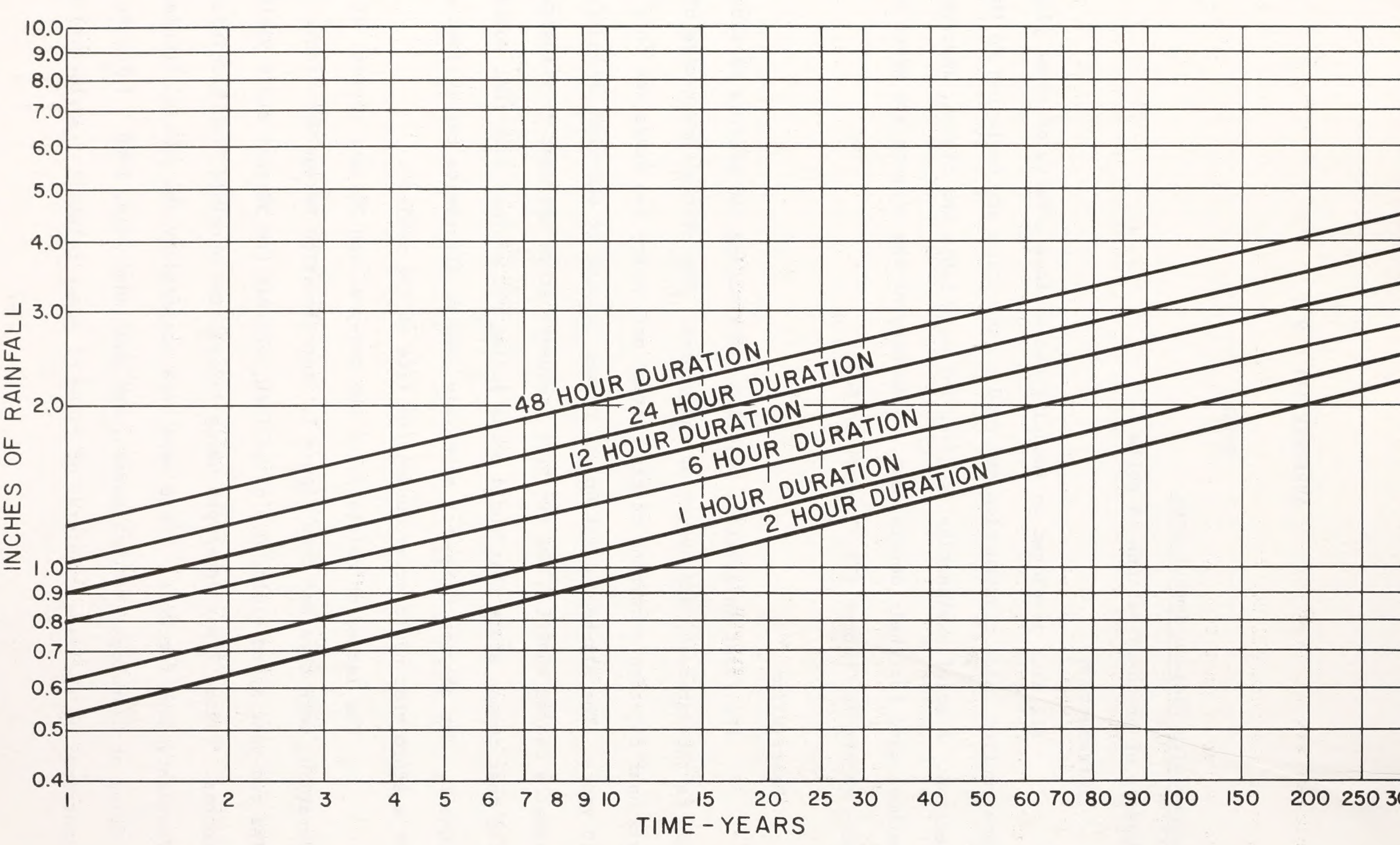
Description

The first information needed for evaluating the effects of erosion was to the intensity and amount of rainstorms. The storms chosen were of a six-hour duration occurring on the average once every two years and once every 50 years. The six-hour duration was chosen because of the high intensity that usually causes runoff. The two year frequency storm was used to illustrate the most common storm that would occur during the project life that would produce runoff. The 50-year frequency storm was used to illustrate the maximum effects of a storm that could occur during the life of the project.

The inches of rainfall for the two-year and 50-year storms, six-hour duration, were obtained from Figure 1, Storm Duration Versus Recurrence in Years. The two-year storm yields 0.9 of an inch, whereas the 50-year storm yields 1.9 inches. Figure 2 was developed using information obtained from precipitation-frequency maps for Utah. These maps were prepared by the Special Studies Branch, Office of Hydrology, Weather Bureau, and published July, 1968. Information contained on the maps consisted of lines of equal rainfall (isopluvial) for various

FIGURE I

Storm Duration Versus
Recurrence in Years



storms of six and 24 hour duration. The information was then plotted on log-paper so the rainfall for two-year and 50-year storms could be identified. The storms of one, two, 12, 24, and 48 hour duration are for illustrative purposes only.

After the amount of rainfall was determined, Figures 2, 3, 4, and 5, were developed to determine the acre-feet of runoff per acre during a 50-year, six-hour duration storm for each of the hydrologic soil groups within each vegetative type. The acre-feet of runoff per acre was obtained by using the Soil Conservation Service Soil Complex Curve Number that was representative for the hydrologic soil group as indicated by the percent ground cover within a specific vegetative type. The percent ground cover includes rock from 1/4 to 2 inches in diameter, dead vegetative matter (litter), plant growth at ground level and plant growth above the ground (tree canopy). The percent ground cover was obtained from Bureau of Land Management Phase 1 Watershed inventories. This information was then plotted on log-paper so that runoff could be determined for any given percent ground cover.

Runoff graphs were not developed for the two-year storms because their curves would not always produce runoff as the amounts were very small.

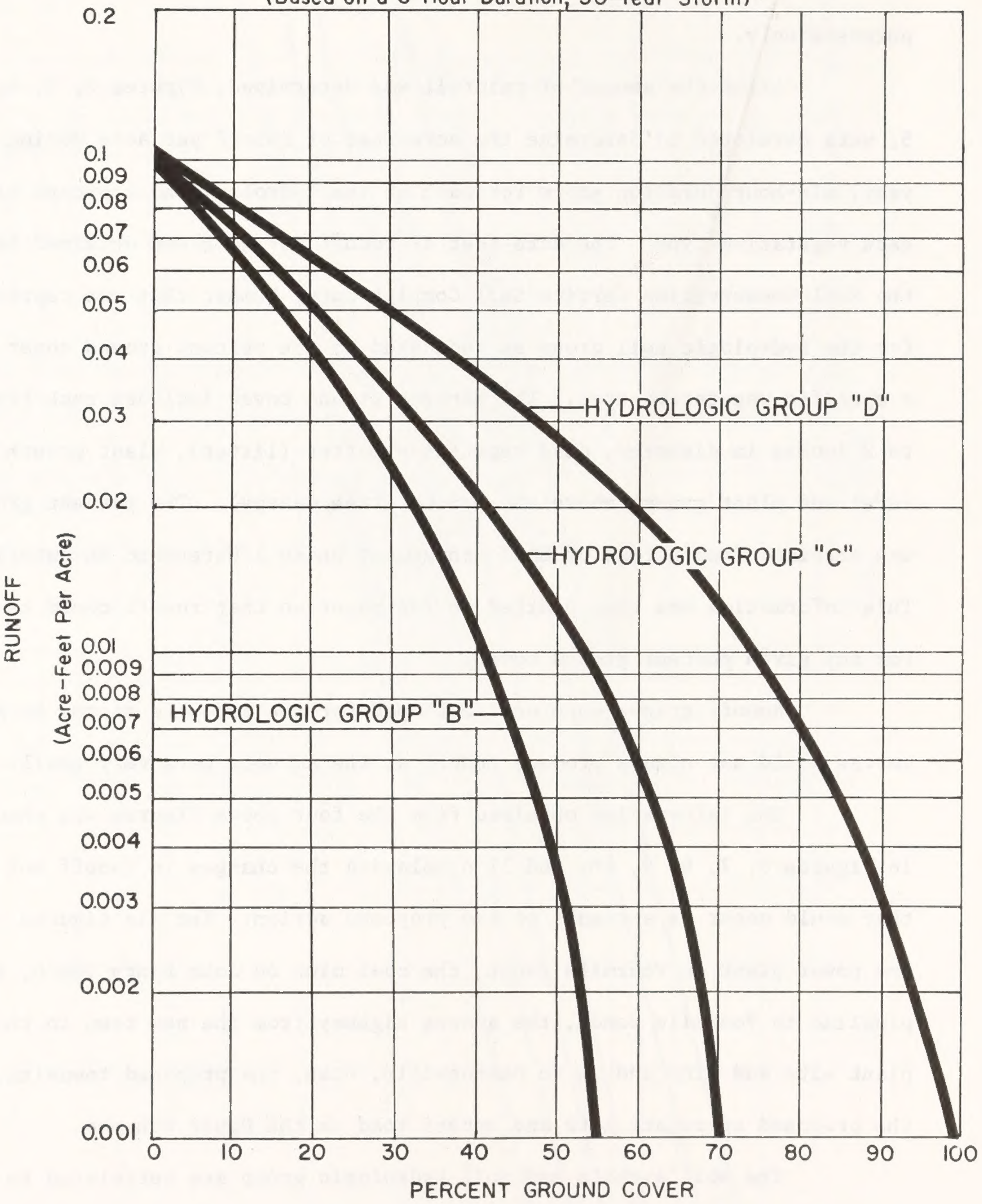
The information obtained from the four above figures was then placed in Figures 6, 7, 8, 9, 10, and 11 displaying the changes in runoff and erosion that would occur as a result of the proposed action. The six figures represent the power plant on Fourmile Bench, the coal mine on John Henry Bench, the water pipeline to Fourmile Bench, the access highway from the new town to the proposed plant site and mine and on to Cannonville, Utah, the proposed townsite, and the proposed aggregate site and access road on the Upper Wahweap.

The soil symbols and soil hydrologic group are correlated to the soils map and description in Soils Appendices II-4 and II-5. The percent ground

FIGURE 2

Runoff Versus Percent Ground Cover in a Sagebrush Stand

(Based on a 6-Hour Duration, 50-Year Storm)*

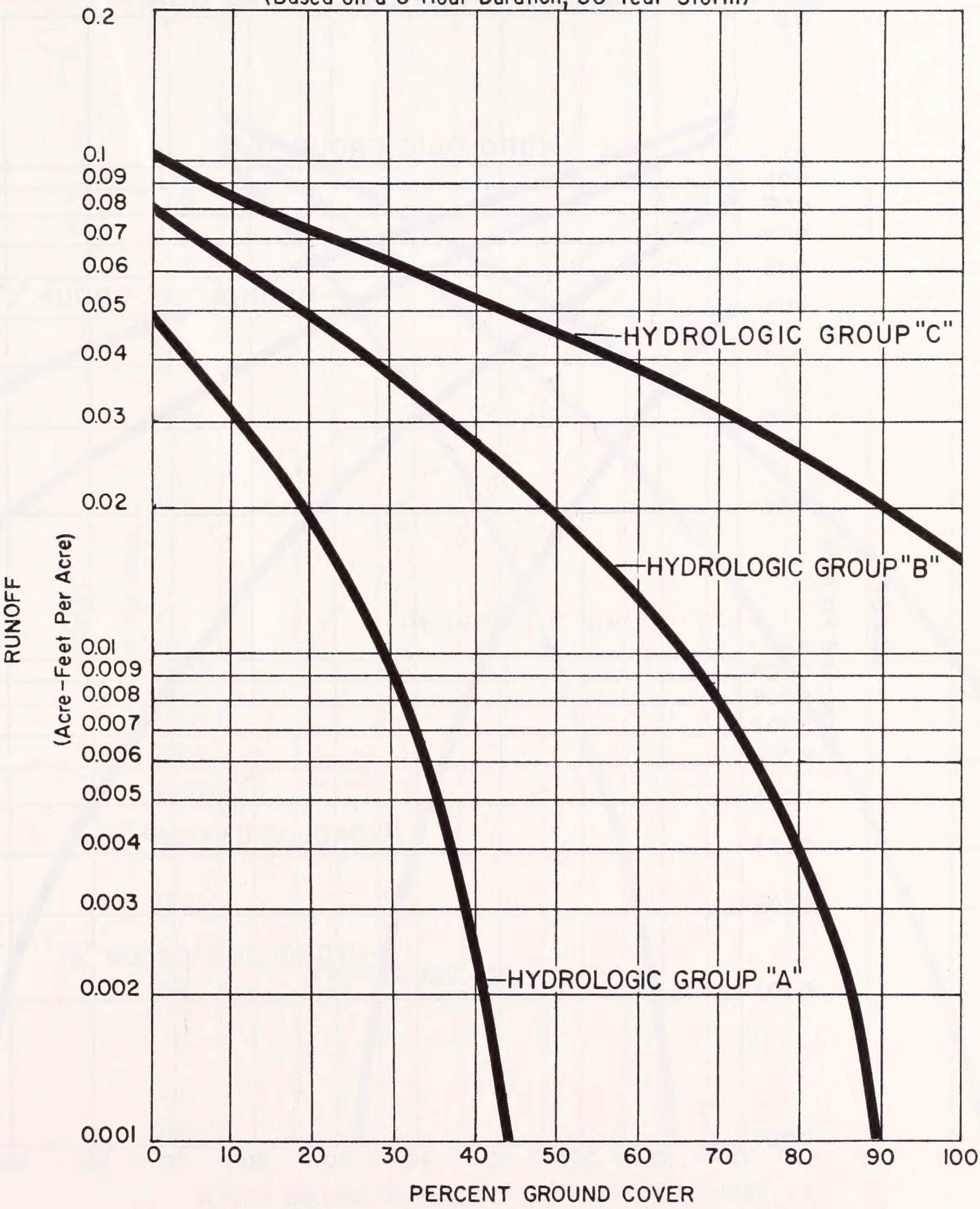


*Developed from Weather Bureau Storm Data and S.C.S. Soil Complex Curve Numbers

FIGURE 3

Runoff Versus Percent Ground
Cover in a Grassland Stand

(Based on a 6-Hour Duration, 50-Year Storm)*

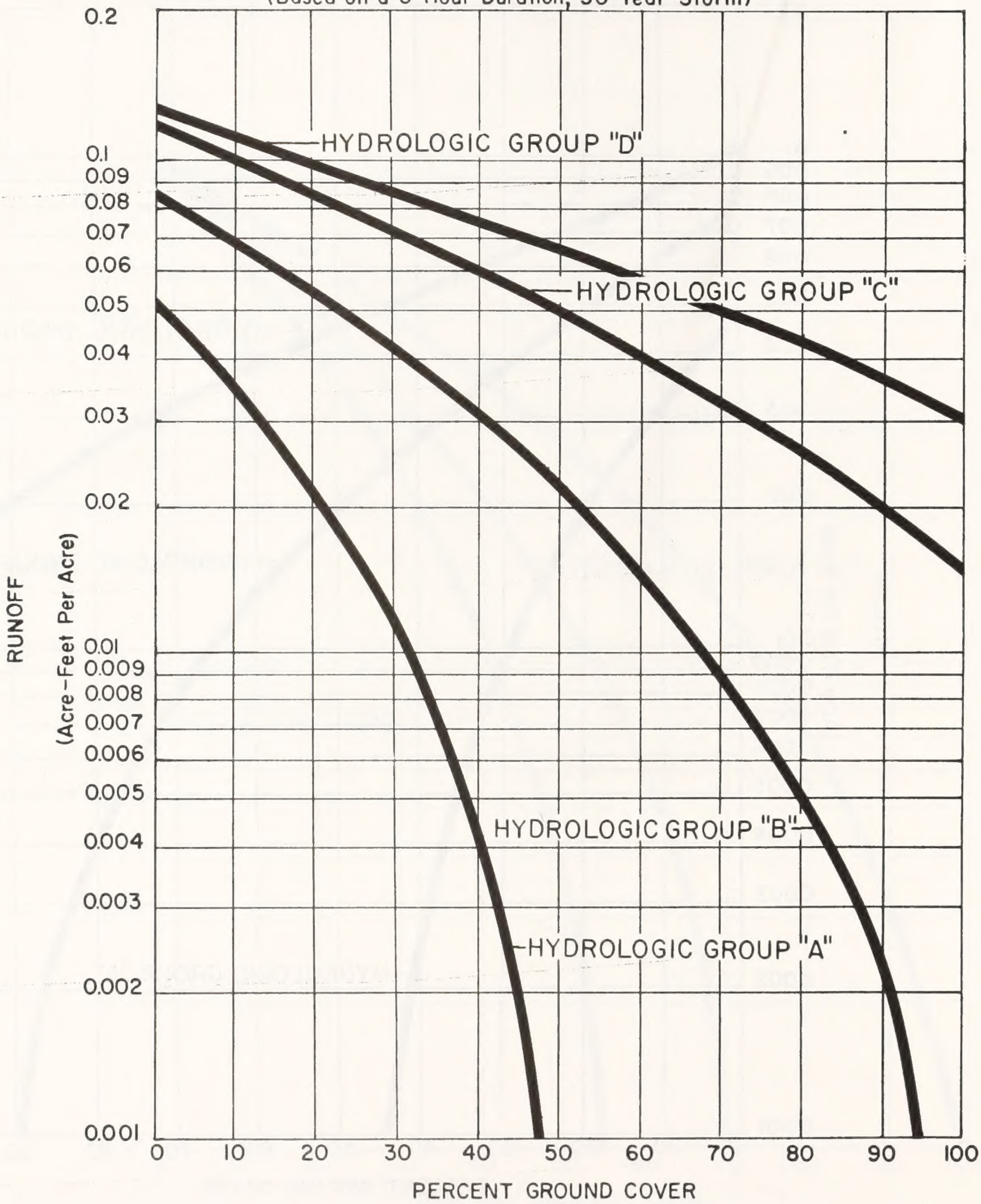


*Developed from Weather Bureau Storm Data
and S.C.S. Soil Complex Curve Numbers

FIGURE 4

Runoff Versus Percent Ground Cover
in Saltbush, Desert Shrub, Saline Flats and Waste Areas

(Based on a 6-Hour Duration, 50-Year Storm)*

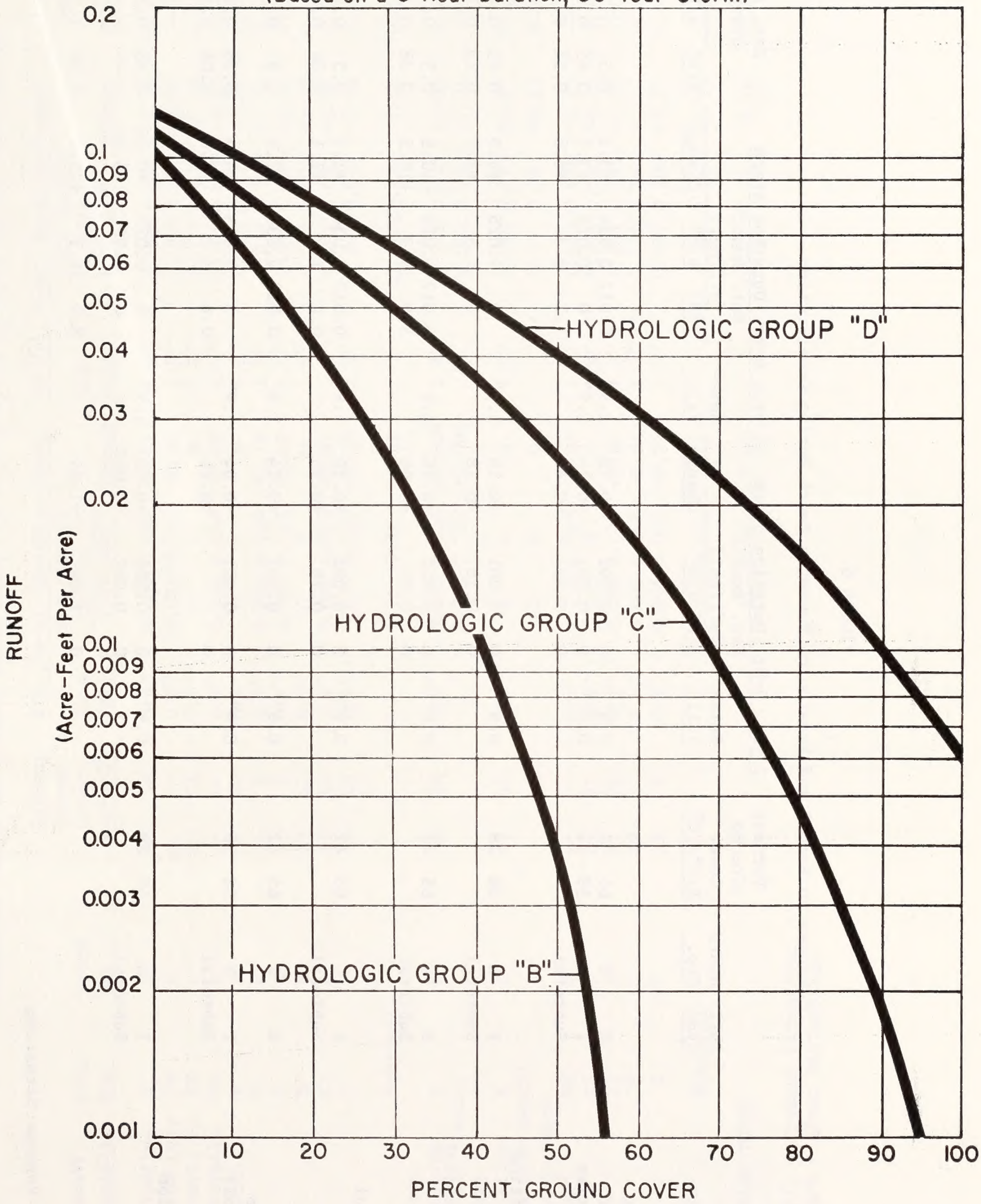


* Developed from Weather Bureau Storm Data and S.C.S. Soil Complex Curve Numbers

FIGURE 5

Runoff Versus Percent Ground Cover
in a Pinyon-Juniper Stand

(Based on a 6-Hour Duration, 50-Year Storm)*



* Developed from Weather Bureau Storm Data and S.C.S. Soil Complex Curve Numbers

FIGURE 6

Changes in Runoff and Erosion on Fourmile Bench During Construction

Facility	Soil Sym.	Hydro Grp.	Percent Ground Cover P/S[a]	A/C[b]	2 yr., 6-hr. Duration Storm Rain-Fall	Est. Runoff (a/f/Ac.) P/S[a]	A/D[b]	Change	50 yr., 6-hr. Duration Storm Rain-Fall	Est. Runoff (a/f/Ac.) P/S[a]	A/D[b]	Change	Est. Annual Sediment Yield (a/f/Mi.^{2}) P/S[a]	A/D[b]	Change
Power Block & Support Facilities	E	C	65	42	0.9"	0	0.002	+0.28	1.9"	0.012	0.034	+3.1	0.5	0.7	+0.04
	I	B	58	28	0.9"	0	0.001	+0.14	1.9"	0	0.025	+3.5	0.45	0.62	+0.04
	Subtotal					0	0.42	+0.42		1.7	8.3	+6.6	0.21	0.29	0.08
Evaporation Ponds	I	B	58	28	0.9"	0	0.001	+0.18	1.9"	0	0.025	+4.5	0.45	0.62	+0.04
	Subtotal					0	0.18	+0.18		0	4.5	+4.5	0.13	0.17	+0.04
Ash Disposal Area	E	C	65	42	0.9"	0	0.002	+0.96	1.9	0.012	0.034	+10.5	0.5	0.7	+0.15
	Subtotal					0	0.96	+0.96		5.8	16.3	+10.5	0.38	0.53	+0.15
Ash Haul Road	E	C	65	42	0.9"	0	0.002	+0.10	1.9"	0.012	0.034	+1.1	0.5	0.7	+0.02
	Subtotal					0	0.10	+0.10		0.6	1.7	+1.1	0.04	0.06	+0.02
Water Storage Reservoir	E	C	65	42	0.9"	0	0.002	+0.14	1.9"	0.012	0.034	+1.5	0.5	0.7	+0.02
	I	B	58	28	0.9"	0	0.001	+0.04	1.9"	0	0.025	+0.9	0.45	0.62	+0.01
	Subtotal					0		+0.18		0.8	3.2	+2.4	0.08	0.11	+0.03
Retention Pond	I	B	58	28	0.9"	0	0.001	+0.002	1.9"	0	0.025	+0.06	0.45	0.62	-----
	Subtotal					0	0.002	+0.002		0	0.06	+0.06	----	----	-----
GRAND TOTAL						0	1.84	+1.84		8.9	34.1	+25.2	0.84	1.16	+0.32

[a] P/A = Present Situation

[b] A/D = After Disturbance

FIGURE 7

Changes in Runoff and Erosion Along Water Pipeline to Fourmile Bench During Construction

Facility	Soil Sym	Hydro Grp.	Percent Ground Cover		2Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
					Rain-Fall	Est. Runoff (a/f/Ac.)			Rain-Fall	Est. Runoff (a/f/Ac.)					
			P/C[a]	A/C[b]		P/S[a]	A/D[b]	Change		P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Pipeline	I	B	30	16	0.9"	0.002	0.008	+0.11	1.9"	0.011	0.025	+0.26	0.45	0.54	+0.003
from Lake	VV	D	--	--	0.9"	0.014	0.018	+0.03	1.9"	0.069	0.078	+0.07	----	----	------
Powell to	KK	C	82	72	0.9"	0	0	0	1.9"	0.025	0.031	+0.32	0.65	0.69	+0.003
Fourmile	WW	D	--	--	0.9"	0.014	0.018	+0.08	1.9"	0.069	0.078	+0.17	----	----	------
Bench	K	B	67	49	0.9"	0	0	0	1.9"	0.010	0.023	+0.84	0.45	0.54	+0.009
	T	C	24	9	0.9"	0.014	0.024	+0.76	1.9"	0.077	0.100	+1.74	0.55	0.62	+0.008
	I	B	28	8	0.9"	0.004	0.012	+0.42	1.9"	0.012	0.035	+1.22	0.45	0.56	+0.009
	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.33	0.45	0.54	+0.005
	UU	D	81	76	0.9"	0.004	0.005	+0.02	1.9"	0.042	0.045	+0.06	1.20	1.30	+0.003
	I	B	58	28	0.9"	0	0.001	+0.10	1.9"	0	0.025	+2.46	0.65	0.69	+0.006
	Subtotal					1.76	3.28	+1.52		11.36	18.83	7.47	0.37	0.41	+0.04
Pump Station	I	B	30	16	0.9"	0.002	0.008	+0.006	1.9"	0.011	0.025	+0.01	0.45	0.54	-----
(Lake Powell)						0.002	0.008	+0.006		0.011	0.025	+0.01	----	----	-----
Pump Station	K	B	67	49	0.9"	0	0	0	1.9"	0.010	0.023	+0.17	0.45	0.54	+0.002
(Nipple Bench)						0	0	0		0.13	0.30	+0.17	0.0090.911		+0.002
Maintenance Road	WW	D	--	--	0.9"	0.014	0.018	+0.11	1.9"	0.069	0.078	+0.25	----	----	------
	KK	C	82	72	0.9"	0	0	0	1.9"	0.025	0.031	+0.13	0.65	0.69	+0.001
	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.03	1.20	1.30	+0.002
	T	C	49	37	0.9"	0.006	0.009	+0.04	1.9"	0.050	0.062	+0.14	0.55	0.60	+0.001
	T	C	29	9	0.9"	0.004	0.024	+0.24	1.9"	0.077	0.100	+0.28	0.55	0.62	+0.001
	Subtotal					0.55	0.95	0.40		4.46	5.29	+0.83	0.07	0.08	+.01
GRAND TOTAL						2.31	4.24	+1.93		15.96	24.44	8.48	0.45	0.50	+0.05

[a] P/S = Present Situation
[b] A/D = After Disturbance

FIGURE 8

Changes in Runoff and Erosion on John Henry Bench During Construction

Facility	Soil Sym	Hydro Grp.	Percent Ground Cover P/S[a]	A/C[b]	2 Yr., 6-Hr. Duration Storm Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	50 Yr., 6-hr. Duration Storm Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	Est. Annual Sediment Yield (a/f/$Mi.^2$) P/S[a]	A/D[b]	Change
Administ.	DD	B	33	11	0.9"	0.002	0.011	+0.45	1.9"	0.036	0.066	+1.5	0.50	0.64	+0.01
Buildings	Subtotal					0.10	0.55	+0.45	1.9"	1.80	3.30	+1.5	0.04	0.05	+0.01
Washery	DO	B	33	11	0.9"	0.002	0.011	+0.45	1.9"	0.036	0.066	+1.5	0.50	0.64	+0.01
& Silos	Subtotal					0.10	0.55	+0.45		1.80	3.30	+1.5	0.04	0.05	+0.01
Mine Port-	C	B	77	44	0.9"	0	0	0	1.9"	0	0.001	+0.02	0.45	0.56	+0.005
als &	DD	B	33	11	0.9"	0.002	0.011	+0.65	1.9"	0.036	0.066	+2.17	0.50	0.64	+0.016
Vent Fans	Subtotal					0.14	0.79	+0.65		2.59	4.78	+2.19	0.07	0.09	+0.02
Tailings	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+6.05	0.45	0.54	+0.03
Pond	Subtotal					0	0	0		1.65	7.70	+6.05	0.39	0.46	+0.07
Water	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.25	0.45	0.54	+0.002
Pond	Subtotal					0	0	0		0.07	0.32	+0.25	0.02	0.022	+0.002
Refuse	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+6.05	0.45	0.54	+0.07
Dump	Subtotal					0	0	0		1.65	7.70	+6.05	0.39	0.46	+0.07
Sewage	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.66	0.45	0.54	+0.01
Pond	Subtotal					0	0	0		0.18	0.84	+0.66	0.04	0.05	+0.01
Training	II	C	90	67	0.9"	0	0.002	+0.04	1.9"	0.020	0.033	+0.26	0.85	1.10	+0.01
Mine	Subtotal					0	0.04	+0.04		0.04	0.66	+0.26	0.02	0.03	+0.01
Road to	C	B	77	44	0.9"	0	0	0	1.9"	0.007	0.007	+0.02	0.45	0.54	+0.001
Training	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.01	1.20	1.30	+0.001
Mine	II	C	90	67	0.9"	0	0.002	+0.04	1.9"	0.020	0.033	+0.28	0.85	1.10	+0.02
	Subtotal					0.02	0.07	+0.05		0.68	0.99	+0.31	0.04	0.06	+0.02
Conveyor &	DD	B	33	11	0.9"	0.002	0.011	+0.11	1.9"	0.036	0.066	+0.36	0.50	0.64	------
Road to	C	B	77	44	0.9"	0	0	0	1.9"	0	0.007	+0.42	0.45	0.54	+0.01
Portals	Subtotal					0.02	0.13	+0.11		0.44	1.22	+0.78	0.05	0.06	+0.01
Water	II	C	90	67	0.9"	0	0.002	+0.01	1.9"	0.020	0.033	+0.08	0.85	0.98	+0.001
Pipeline	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.10	0.45	0.54	+0.001
	DD	B	33	11	0.9"	0.002	0.011	+0.02	1.9"	0.036	0.066	+0.08	0.50	0.64	------
	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.01	1.20	1.30	+0.001
	Subtotal					0.02	0.06	+0.04		0.36	0.63	+0.27	0.02	0.023	+0.003
Conveyor	DD	B	33	11	0.9"	0.002	0.011	+0.14	1.9"	0.036	0.066	+0.45	0.50	0.64	+0.003
to Dump	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.02	1.20	1.30	+0.002
	Subtotal					0.06	0.21	+0.15		0.87	1.34	+0.47	0.02	0.03	+0.01
Temp.	DD	B	33	11	0.9"	0.002	0.011	+0.68	1.9"	0.036	0.066	+2.25	0.50	0.64	+0.02
Coal Dump	Subtotal					0.15	0.83	+0.68		2.70	4.95	+2.25	0.06	0.08	+0.02
	TOTAL					0.61	3.23	+2.62		15.19	37.73	+22.54	1.20	1.47	+0.27

[a] P/S = Present situation
[b] A/D = After Disturbance

FIGURE 9

Changes in Runoff and Erosion Along Access Highways During Construction

			Percent Ground Cover		2 Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
						Est. Runoff (a/f/ac.)				Est. Runoff (a/f/ac.)					
Facility	Soil Sym	Hydro Grp.	P/S[a]	A/C[b]	Rain-Fall	P/S[a]	A/D[b]	Change	Rain-Fall	P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Glen	W	A	53	9	0.9"	0	0	0	1.9"	0	.033	+0.20	0.35	0.40	-------
Canyon	O	D	70	59	0.9"	.008	.024	+0.97	1.9"	.032	.040	+0.48	0.65	0.72	+0.006
City to	WW	C	--	--	0.9"	.014	.018	+0.02	1.9"	.069	.078	+0.06	----	----	-------
Power	T	C	49	37	0.9"	.006	.009	+0.09	1.9"	.050	.062	+0.36	0.75	0.84	+0.005
Plant	LL	C	78	60	0.9"	.001	.003	+0.07	1.9"	.006	.015	+0.28	0.85	1.00	+0.008
	LL	C	78	60	0.9"	0.001	0.003	+0.04	1.9"	.006	.015	+0.16	0.85	1.00	+0.004
	T	C	24	9	0.9"	0.004	0.024	+0.12	1.9"	.077	0.100	+0.14	0.55	6.62	+0.001
	Subtotal					.98	2.74	+1.76		6.12	9.91	+3.79	0.26	0.31	+0.05
Power	II	C	90	67	0.9"	0	0.002	+0.02	1.9"	0.020	0.033	+0.16	0.85	0.98	+0.003
Plant	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.17	0.45	0.54	+0.002
to	DD	B	33	11	0.9"	0.002	0.011	+0.38	1.9"	0.036	0.066	+1.29	0.50	0.64	+0.010
Cannonville	C	B	77	44	0.9"	0	0	0	1.9"	0	0.007	+0.55	0.45	0.56	+0.013
	DD	B	33	11	0.9"	0.002	0.011	+0.38	1.9"	0.036	0.066	+1.27	0.50	0.64	+0.010
	UU	D	81	76	0.9"	0.004	0.005	+0.04	1.9"	0.042	0.045	+0.13	1.20	1.30	+0.007
	C	B	57	22	0.9"	0	0.002	+0.01	1.9"	0	0.036	+0.11	0.45	0.56	-------
	E	C	65	42	0.9"	0	0.002	+0.08	1.9"	0.012	0.034	+0.87	0.50	0.70	+0.012
	I	B	58	28	0.9"	0	0.001	+0.01	1.9"	0	0.025	+0.15	0.45	0.62	+0.002
	Subtotal					0.32	1.07	+0.75		4.56	7.99	3.43	0.21	0.25	+0.04
GRAND TOTAL						1.30	3.81	+2.51		10.68	17.90	+7.22	0.47	0.56	+0.09

[a] P/S = Present Situation

[b] A/D = After Disturbance

FIGURE 10

Changes in Runoff and Erosion on East Clark Bench During Construction

			Percent Ground Cover		2 Yr., 6-Hr. Duration Storm				50 Yr., 6-Hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
						Est. Runoff (a/f/ac.)				Est. Runoff (a/f/ac.)					
Facility	Soil Sym	Hydro Grp.	P/S[a]	A/C b	Rain-Fall	P/S[a]	A/D[b]	Change	Rain-Fall	P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
New Town	0	C	70	59	0.9"	0.001	0.002	+0.64	1.9"	0.032	0.040	+ 5.12	0.65	0.78	+0.13
	W	A	53	9	0.9"	0	0.001	+2.24	1.9"	0	0.033	+73.92	0.35	0.60	+0.88
	0	C	88	71	0.9"	0	0.001	+1.60	1.9"	0.021	0.031	+16.00	0.65	0.70	+0.12
	TOTAL					0.64	5.12	4.48		54.08	149.12	+95.04	3.5	4.63	+1.13

[a] P/S = Present Situation
[b] A/D = After Disturbance

FIGURE 11

Changes in Runoff and Erosion on Aggregate Site and Access Road

Facility	Soil Sym	Hydro Grp.	Percent Ground Cover		2 Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.²)		
					Rain-Fall	Est. Runoff (a/f/ac.)			Rain-Fall	Est. Runoff (a/f/ac.)					
			P/S[a]	A/C[b]		P/S[a]	A/D[b]	Change		P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Access Road	D	B	45	24	0.9"	0	0.002	+0.01	1.9"	0.007	0.033	+0.16	0.60	0.80	+0.002
	H	D	45	17	0.9"	0.001	0.003	+0.02	1.9"	0.033	0.068	+0.25	0.45	0.70	+0.003
	UU	D	87	73	0.9"	0.003	0.004	+0.01	1.9"	0.039	0.048	+0.03	1.25	1.45	+0.001
	TOTAL					0.01	0.05	+0.04		0.41	0.85	+0.44	0.016	0.022	+0.006

[a] P/S = Present Situation

[b] A/D = After Disturbance

cover remaining after disturbance is the rock of 1/4 to 2 inches in diameter that remains after the vegetation and litter have been removed. The changes in runoff as a result of disturbance for the two-year and 50-year storms are also shown. The change in runoff from the 50-year storm was obtained from Figures 2,3, 4, and 5. The change in sediment yield was obtained by subtracting the present estimated sediment yield from the projected sediment yield. The projected sediment yield considered only the changes in ground cover using procedures developed by the Pacific Southwest Interagency Committee.(Shown, 1970) The subtotals and total identify the acre-feet of runoff and sediment from each activity.

Figures 12, 13, 14, 15, 16 and 17 were then developed to identify the acre feet of runoff and sediment prior to, during and after construction of power plant, access roads and highways, water pipeline, coal mine and the proposed town.

The above figures consider only the effects of runoff and erosion and do not consider long-term effects during the life of the project. These will be discussed in the main text of Chapter III. However, access highways and roads are recognized as having a long-term influence on runoff, Because of this long-term effect, Figure 18 was developed to show the project runoff for two-year and 50-year storms of six hour duration on both paved and dirt roads for each of the four hydrologic soil groups. This figure applies only to the Kiaparowits Study Area.

The possibility of heavy metals and CA SO_4 rising through the one-foot soil mantle over the ash disposal area was also examined. Based on Brigham Young University and Bureau of Land Management Phase I Studies the soils range from a fine sandy loam to a loam in texture.

To determine potential capillary rise in the soils involved, the following formula was used: (Baver, 1959)

FIGURE 12

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Power Plant Complex. *

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Power Plant & Support Fac.	0	1.7	0.42	8.3	4.8	10.0	0.21	0.29	0
Evaporation Ponds	0	0	0.18	4.5	0	0	0.13	0.17	0
Ash Disposal Site	0	5.8	0.94	16.3	0.50	11.1	0.38	0.53	0.45
Ash Haul Road	0	0.6	0.10	1.7	1.1	4.3	0.04	0.06	0.05
Water Storage Reservoir	0	0.8	0.18	3.2	0	0	0.08	0.11	0.03
Retention Pond	0	0	0	0.1	0	0	0	0	0
Total	0	8.9	1.84	34.1	6.4	25.4	0.84	1.16	0.53

* Acre-foot is the volume of water or sediment covering one acre the depth of one foot and is equal to 43,560 cubic feet.

FIGURE 13

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Pipeline

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Pipeline	1.76	11.35	3.28	18.83	1.79	12.54	0.37	0.41	0.39
Pump Station (Lake Powell)	0	0.01	.01	0.02	0	.01	0	0	0
Pump Station (Nipple Bench)	0	0.13	0	0.30	0	0	0.01	0.01	0.01
Maintenance Road	0.55	4.46	0.95	5.29	1.34	6.21	0.07	0.08	0.08
Total	2.31	15.96	4.24	24.44	3.13	18.76	0.45	0.50	0.48

FIGURE 14

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Highways

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Glen Canyon to Power Plant	0.98	6.12	2.74	9.91	4.89	21.02	0.26	0.31	0.29
Power Plant to Cannonville	0.32	4.56	1.07	7.99	3.17	13.87	0.21	0.25	0.23
Total	1.30	10.68	3.81	17.90	8.06	34.89	0.47	0.56	0.52

FIGURE 15

Acre-Feet of Runoff and Sediment Prior to,
During and After Construction of Coal Mine Complex

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Admin. Build.	0.10	1.80	0.55	3.30	3.70	7.90	0.04	0.05	0.04
Washery & Silo	0.10	1.80	0.55	3.30	3.70	7.90	0.04	0.05	0.04
Mine Portals	0.14	2.59	0.79	4.92	7.2	15.14	0.07	0.09	0.07
Tailings Pond	0	1.65	0	7.70	0	0	0.39	0.46	0
Water Pond	0	0.07	0	0.32	0	0	0.02	0.02	0
Refuse Pump	0	1.65	0	7.70	0	5.50	0.39	0.46	0
Sewage Pond	0	0.18	0	0.84	0	0	0.04	0.05	0
Training Mine	0	0.40	0.04	0.66	1.49	3.15	0.02	0.03	0
Road to Mine	0.02	0.68	0.07	0.99	0.22	1.08	0.04	0.06	0.05
Conveyor Road	0.02	0.44	0.13	1.22	0.22	1.41	0.05	0.06	0.06
Water Pipeline	0.02	0.36	0.06	0.63	0.02	0.36	0.02	0.023	0.02
Conveyor to Dump	0.06	0.87	0.21	1.34	0.10	0.52	0.02	0.03	0.03
Temp. Coal Dump	0.15	2.70	0.83	4.95	0	0	0.06	0.08	0
Total	0.61	15.19	3.23	37.73	16.65	42.96	1.20	1.47	0.31

FIGURE 16

Acre-Feet of Runoff and Sediment Prior to,
During and After Construction of New Town

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yd.	50 Yd.	2 Yd.	50 Yd.	2 Yd.	50 Yd.	Prior	During	After
New Town	0.64	54.08	5.12	149.12	40.61 (31.4 to 51.5)	223.25 (201.6 to 246.4)	3,50	4.63	4.10

FIGURE 17

Acre-Feet of Runoff and Sediment Prior to,
During and After Construction of Aggregate Access Road

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yd.	50 Yd.	2 Yd.	50 Yd.	2 Yd.	50 Yd.	Prior	During	After
Road	0.01	0.41	0.05	0.85	0.23	1.11	0.016	0.022	0.019

FIGURE 18

Water Runoff in Acre-Feet Per Acre for
Access Roads for Each Soil Hydrologic Group

	Acre Feet of Runoff Per Acres											
Type of Road	A*			B			C			D		
Including Right-of-way	Sxx c c N	xxx 2 yr*** *	50 yr***	s** c c N	2 yr***	50 yr***	s c c N	2 yr***	50 yr***	s c c N	2 yr***	50 yr***
Dirt	72		0.021	82	0.007	0.048	87	0.014	0.069	89	0.018	0.078
Paved	74	0.001	0.026	84	0.009	0.057	90	0.022	0.084	92	0.028	0.096

* Refers to Hydrologic Soil Group - see definition in soils section.

** Soil complex curve number as derived from Bureau of Land Management Erosion manual.

*** Storms are of 6-hour duration.

$$h = \frac{2T}{r\ d\ g}$$

h = Potential height in centimeters

T = Surface tension of water (75 dynes/centimeter)

r = radius of soil pores in centimeter

d = density of water (1 gram / cubic centimeters)

g = Gravitational acceleration (980 centimeters / second/second)

Capillary pore size is dependent on the particle size of soil particles. Figure 19, Particle Size Distribution, identifies the particle size that one can expect for fine sandy loam and loam textured soils.

Figure 19

Particle Size Distribution

		Fine Sandy Loam		Loam	
Particle	Average Dia. (CM)	Percent of Total Vol.	Adjusted Diameter	Percent of Total Vol.	Adjusted Diameter
Sand	0.08	51	0.0408	35	0.028
Clay	0.00015	20	0.00003	28	0.0004
Silt	0.0026	29	0.00075	37	0.00096
New particle diameter			0.04158		0.029

Assuming soil particles are uniformly dispersed, sized, and placed together then the average capillary pore radius is approximately one sixth the average particle size. The average capillary pore radius for fine sandy loam approximately one sixth the average particle size. The average capillary pore radius for fine sandy loam is 0.0069 centimeters (0.04158/6), whereas the capillary pore radius is 0.0048 centimeters (0.029/6) for loam.

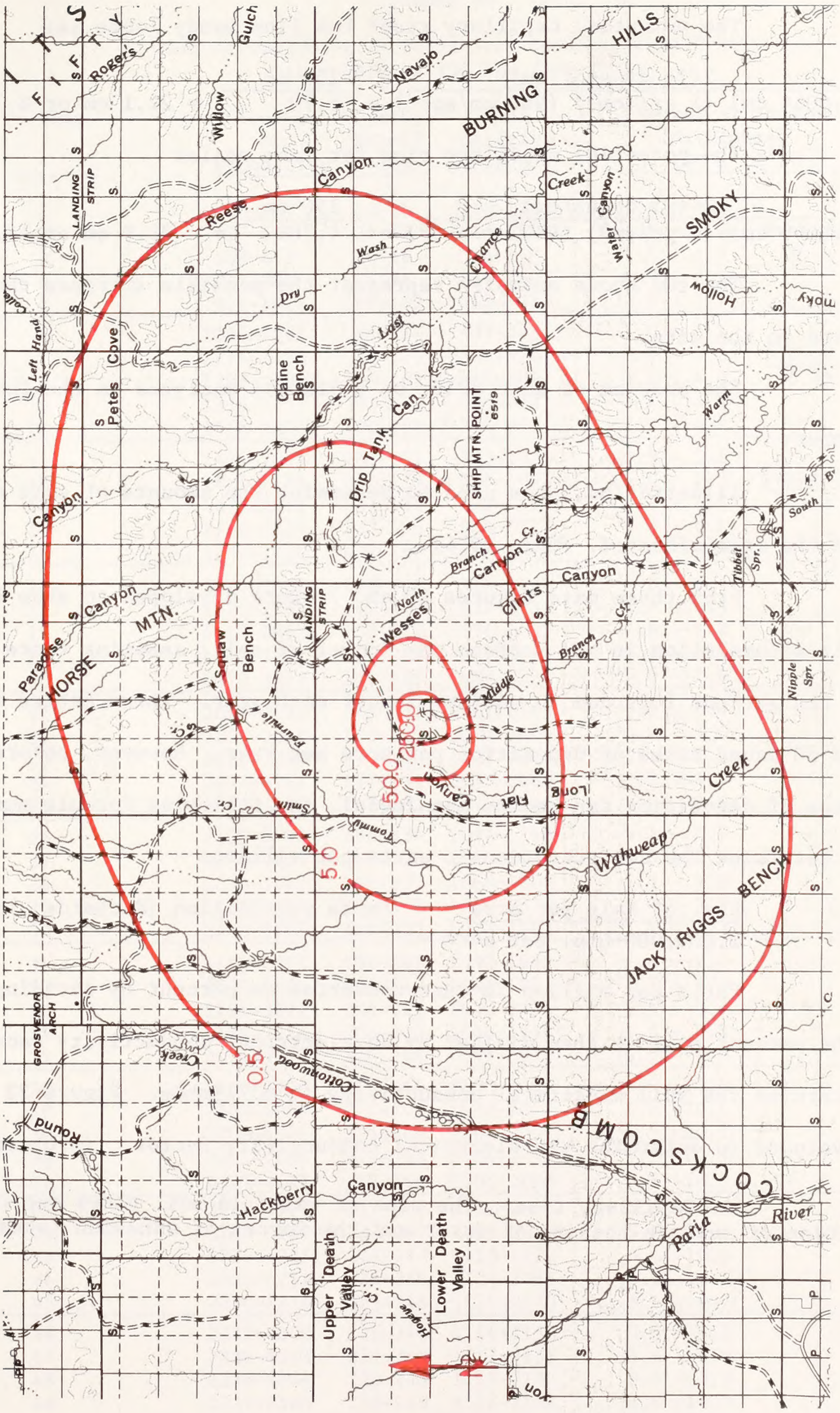


ILLUSTRATION 1

Isopleths of Salt Deposition

The potential capillary rise* for fine sandy loams is:

$$\frac{2(74 \text{ dynes / cm})}{(0.0069 \text{ cm})\ (1 \text{ gr/ cm}^3)\ (980 \text{ cm/sec}^2)} = \frac{150 \text{ cm}}{6.79} = 22.1 \text{ cm or } 8.7 \text{ inches}$$

The potential capillary rise for loam soils:

$$\frac{2\ (75 \text{ dynes/cm})}{(0.0048 \text{ cm})\ (1 \text{ gr/cm}^3)\ (980 \text{ cm/sec}^2)} = \frac{150 \text{ cm}}{4.704} = 31.9 \text{ cm or } 12.6 \text{ inches}$$

The two above examples represent the possible extremes that may be found on the site.

The problem of salt drift on soils was analyzed in the following manner:

Illustration 1 was used to determine the amounts of salt deposition and the area affected. (MRI, 1974)

From these data Figures 20 and 21 were developed to show the annual salt accumulation in the surface six inches of soil, assuming there is a five to ten percent loss due to surface runoff each year. These tables are for 250 and 50 pound rates of deposition per acre per year. However, before these annual rates of deposition can become meaningful, the following formula must be used to determine the concentration in parts per million:

$$\frac{\text{Lbs. of Salt per acre}}{2{,}000{,}000 \text{ Lbs. per acre}} = \text{Parts per Million (Richards, 1954),}$$

Parts per million is then converted to percent by dividing by $10,000. The percent salt is then divided by an electrical conductivity factor to determine the soil electrical conductivity in millimhos. Figure 22 was developed to determine the electrical conductivity factor. (Richards, 1954)

* Capillary rise: The rise of water in soil pores due to the interaction of surface tension of water and the forces of adhesion (attachment).

FIGURE 20

Salt Accumulation in Soils from Cooling Tower Drift At a Rate of 250 Lbs./Acre/Year

Year	Yearly Acc. Deposition	Yearly Runoff (5-10%)	Soil Salinity (P.P.M.)	Electrical Conduct. (Millimhos) (EC x 10^3)	
1	225-237	13-25	112-118	0.6 - 0.6	
2	427-463	24-48	213-231	1.1 - 1.2	Present Soil
3	609-677	36-68	305-338	1.5 - 1.7	Ec x 10^3
4	773-881	46-86	386-440	1.9 - 2.2	
5	921-1074	57-102	460-537	2.3 - 2.7	
6	1054-1258	66-117	427-629	2.6 - 3.1	
7	1174-1433	75-130	587-716	2.9 - 3.6	Nipple Bench
8	1282-1599	84-142	641-799	3.2 - 4.0	0.85 x 10^3
9	1379-1757	92-153	689-878	3.4 - 4.4	
10	1466-1907	100-163	733-953	3.7 - 4.8	
11	1544-2049	108-172	772-1024	3.9 - 5.1	
12	1615-2184	115-179	808-1092	4.0 - 5.5	Fourmile Bench
13	1679-2312	122-186	839-1156	4.2 - 5.8	1.1 x 10^3
14	1736-2434	128-196	868-1217	4.3 - 6.1	
15	1787-2550	134-199	893-1275	4.5 - 6.4	
16	1833-2660	140-204	916-1330	4.6 - 6.7	
17	1875-2764	146-208	937-1382	4.7 - 6.9	
18	1913-2863	151-212	956-1431	4.8 - 7.2	
19	1947-2957	156-216	973-1478	4.9 - 7.4	
20	1977-3046	161-220	988-1523	4.9 - 7.6	
21	2004-3131	165-223	1002-1565	5.0 - 7.8	
22	2029-3211	170-225	1014-1605	5.1 - 8.0	
23	2051-3288	173-228	1025-1644	5.1 - 8.2	
24	2071-3361	177-230	1035-1680	5.2 - 8.4	
25	2089-3430	181-232	1044-1715	5.2 - 8.6	
26	2105-3496	184-234	1052-1748	5.3 - 8.7	
27	2120-3559	187-235	1060-1779	5.3 - 8.9	
28	2133-3618	191-237	1066-1809	5.3 - 9.0	
29	2145-3674	194-238	1072-1837	5.4 - 9.2	
30	2156-3727	197-239	1078-1863	5.4 - 9.3	
31	2165-3778	199-241	1082-1889	5.4 - 9.4	
32	2173-3826	202-242	1086-1913	5.4 - 9.6	
33	2181-3872	204-242	1090-1936	5.5 - 9.7	
34	2188-3916	206-243	1094-1958	5.5 - 9.8	
35	2194-3958	208-244	1097-1979	5.5 - 9.9	
36	2200-3998	210-244	1100-1999	5.5 -10.0	
37	2205-4035	213-245	1102-2017	5.5 -10.1	
38	2209-4071	214-246	1104-2035	5.5 -10.2	
39	2213-4105	216-246	1106-2052	5.5 -10.3	
40	2217-4137	218-246	1108-2068	5.5 -10.3	
41	2220-4168	219-247	1110-2084	5.6 -10.4	
42	2223-4197	221-247	1111-2098	5.6 -10.5	
43	2226-4225	222-247	1113-2112	5.6 -10.6	
44	2228-4251	224-248	1114-2125	5.6 -10.6	
45	2230-4276	225-248	1115-2138	5.6 -10.7	
46	2232-4300	226-248	1116-2150	5.6 -10.8	
47	2234-4323	227-248	1117-2161	5.6 -10.9	
48	2236-4364	230-249	1118-2182	5.6 -10.9	
49	2237-4364	230-249	1118-2182	5.6 -10.9	
50	2238-4383	231-249	1119-2191	5.6 -11.0	

Total 8,117-10,265

FIGURE 21

Salt Accumulation in Soils from Cooling Tower Drift At a Rate of 50 Lbs./Acre/Year

Year	Yearly Acc. Deposition	Yearly Runoff (5-10%)	Soil Salinity (P.P.M.)	Electrical Conduct. (Millimhos) (EC x 10^3)	
1	45- 48	2-5	22- 24	0.11 - 0.12	
2	86- 88	5-9	43- 44	0.22 - 0.22	
3	124-131	7-12	62- 65	0.31 - 0.32	Present Soil
4	157-172	9-17	78- 86	0.39 - 0.43	Ec x 10^3
5	186-220	12-21	93-110	0.47 - 0.55	
6	212-257	13-24	106-128	0.53 - 0.64	
7	236-292	15-26	118-146	0.59 - 0.73	Nipple Bench
8	257-325	17-29	128-162	0.64 - 0.81	
9	276-356	19-31	138-178	0.69 - 0.89	0.85 x 10^3
10	293-386	20-33	146-193	0.73 - 0.97	
11	309-414	22-34	154-207	0.77 - 1.03	
12	323-441	23-36	161-220	0.80 - 1.10	Fourmile Bench
13	336-466	25-37	168-233	0.84 - 1.17	
14	347-490	26-39	173-245	0.87 - 1.23	1.1 x 10^3
15	357-513	27-40	178-256	0.89 - 1.28	
16	366-535	28-41	183-267	0.92 - 1.34	
17	374-556	29-42	187-278	0.94 - 1.39	
18	382-575	30-42	191-287	0.96 - 1.44	
19	389-594	31-43	194-297	0.97 - 1.49	
20	395-612	32-44	197-306	0.99 - 1.53	
21	400-629	33-45	200-314	1.00 - 1.57	
22	405-645	34-45	202-322	1.01 - 1.61	
23	410-660	35-45	205-330	1.02 - 1.65	
24	419-675	35-46	209-337	1.04 - 1.69	
25	422-689	36-47	211-344	1.05 - 1.72	
26	425-702	37-47	212-351	1.06 - 1.76	
27	428-714	38-47	214-357	1.07 - 1.79	
28	430-726	38-48	215-363	1.08 - 1.82	
29	432-737	39-48	216-368	1.08 - 1.84	
30	434-748	39-48	217-374	1.09 - 1.87	
31	436-758	40-48	218-379	1.09 - 1.90	
32	437-768	40-49	218-384	1.09 - 1.92	
33	438-777	41-49	219-388	1.10 - 1.94	
34	439-786	41-49	219-393	1.10 - 1.97	
35	440-796	42-49	220-398	1.10 - 1.99	
36	441-804	42-49	220-402	1.10 - 2.01	
37	442-811	43-49	221-405	1.11 - 2.03	
38	443-818	43-49	221-409	1.11 - 2.05	
39	444-825	43-49	222-412	1.11 - 2.06	
40	445-831	44-49	222-415	1.11 - 2.08	
41	446-836	44-49	223-418	1.12 - 2.09	
42	446-842	44-50	223-421	1.12 - 2.11	
43	446-847	45-50	223-423	1.12 - 2.12	
44	446-852	45-50	223-426	1.12 - 2.13	
45	446-857	45-50	223-428	1.12 - 2.14	
46	446-862	45-50	223-431	1.12 - 2.16	
47	446-866	46-50	223-433	1.12 - 2.17	
48	446-870	46-50	223-435	1.12 - 2.18	
49	446-874	46-50	223-437	1.12 - 2.19	
50	446-878	46-50	223-439	1.12 - 2.20	
Total		1629 - 2059			

FIGURE 22

Electrical Conductivity Factor for Various Soil Textures

Textural Class	Range of Saturation (%)	Elec. Fact. Range	Average Elect. Fact
Coarse	12.5 to 25	0.008-0.016	0.012
Mod.-Coarse	25 to 37.5	0.016-0.024	0.020
Medium	37.5 to 50	0.024-0.032	0.028
Mod.-Fine	50 to 75	0.032-0.048	0.040
Fine	75 to 100	0.048-0.064	0.056

Because the soils involved are sandy loam a factor of 0.020 was used.

Figure 23 was developed to show the time sequence of salt deposition and its effects on vegetation. The assumptions on the salt effects on vegetation are also in the table. Salt concentration, as expressed in millimhos, is an indicator of salinity hazard.

The alkalinity hazard is determined by the Sodium Absorption Ratio. (SAR). The SAR is determined by the following formula:

$$\frac{Na}{\frac{Ca + Mg}{2}} = SAR$$

The concentrations of sodium, calcium and magnesium are expressed in milliequivalents.

FIGURE 23

Time Sequence of Salt Deposition (in Millimhos) on Soils and Vegetation for Fourmile Bench

Ave. Radius from Cooling Towers (Miles)	Ave. Salt Deposition (lb./Ac./Yr.)	Area in Acres	Accum. Area in Acres	Years for Soil[a] to Attain Selected Elec. Cond. Levels[b]			Soil Elec. Conductivity Levels at the end of 35 and 50 Year Periods	
				4 X 10^3	6 X 10^3	12 X 10^3	Lapse of 35 Yrs.	Lapse of 50 Yrs.
0.00-0.40	250.0	320	320	6	10	49	11.00 X 10^3	12.06 X 10^3
0.40-0.52	187.5	220	540	8	16	--	8.53 X 10^3	9.32 X 10^3
0.52-0.55	115.0	70	610	15	44	--	5.66 X 10^3	6.14 X 10^3
0.55-0.64	95.0	215	825	20	--	--	4.86 X 10^3	5.27 X 10^3
0.64-0.78	75.0	400	1255	28	--	--	4.07 X 10^3	4.39 X 10^3
0.78-0.96	55.0	635	1860	--	--	--	3.28 X 10^3	3.51 X 10^3 [c]
0.96-1.18	35.0	940	2800	--	--	--	2.49 X 10^3	2.63 X 10^3
1.18-1.23	23.75	240	3040	--	--	--	2.04 X 10^3	2.14 X 10^3
1.23-1.32	21.63	460	3500	--	--	--	1.96 X 10^3	2.05 X 10^3
1.32-1.46	19.38	790	4290	--	--	--	1.87 X 10^3	1.95 X 10^3
1.46-1.65	17.13	1180	5470	--	--	--	1.78 X 10^3	1.85 X 10^3
1.65-1.89	14.88	1710	7180	--	--	--	1.69 X 10^3	1.75 X 10^3
1.89-2.17	12.63	2285	9465	--	--	--	1.60 X 10^3	1.65 X 10^3
2.17-2.50	10.38	3100	12565	--	--	--	1.51 X 10^3	1.55 X 10^3
2.50-2.88	8.13	4115	16680	--	--	--	1.42 X 10^3	1.46 X 10^3
2.88-3.31	5.88	5350	22030	--	--	--	1.33 X 10^3	1.36 X 10^3
3.31-3.78	3.63	6700	28730	--	--	--	1.24 X 10^3	1.26 X 10^3

[a] The present electrical conductivity of the Fourmile Bench soils is 1.1 X 10^3 (millimos)

[b] The soil electrical level as expressed in millimhos is an indicator of salinity hazard.

[c] The following assumptions were made for the salinity tolerance of various types of vegetation (Gates, Stoddard & Cook, 1956) (Richard, 1954) (Bernstein, 1958)

4 X 10^3 - The upper limit of sagebrush and pinyon-juniper vegetation

6 X 10^3 - The upper limit of most grasses and forbs.

12 X 10^3 - The upper limit of all grasses and forbs.

16 X 10^3 - The upper limit of salt tolerant shrubs.

APPENDIX III-10

Acres of Vegetation by Major Type Lost to Structural Features

APPENDIX III-10

FIGURE 1

Vegetation

Kaiparowits Plateau impact area

Acres of vegetation by major type lost to structural features

Project Feature	VEGETAL TYPE													
	Barren		Pinyon-Juniper Woodland		Mixed Shrub-Grass-Scattered Juniper		Salt Desert Shrub-Desert Grass		Riparian Bottomland		Scattered Ponderosa-&Bristlecone Pine		Totals	
	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temp.	Permanent	Temporary	Perm.	Temp.
Plant Site	-	-	932	1,172	-	-	-	-	-	-			932	1,172
Water Pipeline	100	275	25	70			100	275	-	-			225	620
Mine	-	-	-	-	1,649	1,814	-	-	-	-			1,649	1,814
Aggregate Sites and access road	15	15					317	405					332	420
New Town	-	-	-	-	200	300	3,700	4,700	-	-			3,900	5,000
Highway	28	40	87	118	55	89	83	119	27	39			280	405
Limestone Quarry	-	-	156	156	36	36					48	48	240	240
UP&L 138 kV line			7	14	6	0							13	14
	143	330	1,207	1,530	1,946	2,239	4,200	5,499	27	39	48	48	7,571	9,685
Total														
Permanent	7,571													
Temporary	9,685													

APPENDIX III - 11

Museum of Northern Arizona Report

APPENDIX III - 11

MUSEUM OF NORTHERN ARIZONA

DEPARTMENT OF GEOLOGY

Southern California Edison Company

Kaiparowits Power Project

Private, State of Arizona, State of Utah and

Bureau of Land Management Lands, Kanab District,

Washington and Kane Counties, Utah

Coconino County, Arizona

Phase I Report

for

Paleontological Investigations

Phase I - Kaiparowits Power Project; Report of

Paleontological Resources on Plant Sites, Related Facilities,

Associated Access Roads, Impact Area, and

Proposed Transmission Lines

Prepared and Submitted by:

Larry G. Marshall

Supervisory Paleontologist
Museum of Northern Arizona

and

William J. Breed

Curator of Geology
Museum of Northern Arizona

August 12, 1974

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Introduction

This report presents the results of an overview study of paleontological resources on areas to be impacted by the proposed Kaiparowits Power Plant Sites (Fourmile Bench Site and Nipple Bench Site) and associated Transmission Lines Sites (Kaiparowits Power Plant to Eldorado; and Kaiparowits Power Plant via Moenkopi Substation to Mohave). This study was supported by a grant from Southern California Edison Company (SCE) (purchase orders U1754001 dated 6/20/74 and U4895151 dated 7/3/74).

The study was done in two parts. The first involved a literature survey to determine 1) what geological formations are exposed in the areas covered by this project, 2) what specific paleontological studies and findings have been made with regard to these formations, both within and outside of the project areas, and 3) what paleontological resources might be expected to occur within the project areas in exposures of these formations which have not yet been subjected to paleontological examination. This part of the study was undertaken from July 22 to July 26, 1974. A summary of the literature findings was presented in a report to Mr. Michael Gardner, dated July 31, 1974. For the sake of completion this data is again discussed in the present report.

The second part of the study involved a field spot checking of the project areas with emphasis on 1) locations of plant sites, mines, and related facilities where extensive alteration of the surface and underlying rock can be expected to occur during construction and operation of the power facilities, 2) transmission line corridors, and 3) previously unstudied or poorly studied exposures of formations known to contain significant paleontological material. The second part of this study was undertaken from August 5 to August 8, 1974. August 5th and 6th were spent at the Fourmile Bench Plant Site, August 7th was spent flying the Kaiparowits Power Plant to Eldorado Transmission Line Corridor by helicopter, and August 8th was spent on the Nipple Bench Site and mine sites. Data on the Kaiparowits Power Plant via Moenkopi Substation to Mohave Transmission Line Corridor is based strictly on the literature survey.

The survey was conducted by the following personnel of the Department of Geology, Museum of Northern Arizona: Mr. William J. Breed (Administrator); Mr. Larry G. Marshall (Senior Paleontologist); Mr. Tim Rowe (Supervisory Paleontologist); and Miss Gail Armstrong (Laboratory Technician). Helicopter transportation was supplied by SCE for August 7 and 8 and the pilot was Mr. John Scheidemantle.

Plant Sites

Within the area of the proposed plant sites (Fourmile Bench Site and Nipple Bench Site) occur exposures of nine geological formations. These are, from youngest (top) to oldest (bottom):

Kaiparowits Formation	Cretaceous
Wahweap Sandstone	
Straight Cliffs Sandstone	
Tropic Shale	
Dakota Sandstone	
Morrison Formation	Jurassic
Entrada Sandstone	
Carmel Formation	
Navajo Sandstone	Triassic-Jurassic boundary

All are of Mesozoic Age (latest Triassic to late Cretaceous) or approximately 180 to 65 million years old.

Fossil faunas and floras recorded from these formations along with literature references are presented in Appendices I-IX respectively. Fossils from these formations known to occur in the Kaiparowits Plateau Region are marked by an asterisk(*).

Fourmile Bench Site (Fig. 1): Two geologic formations are exposed on the Fourmile Bench Site. The Kaiparowits Formation is exposed on the northern half and the Wahweap Sandstone is exposed on the southern half.

Eight fossil sites were found on the Fourmile Bench Site (see Fig. 1, and Appendix XIII). Six of these occur in the Kaiparowits Formation and two in the underlying Wahweap Sandstone.

Site K-1 is the most important locality on the lease area. Dinosaur bones, fragments of turtle shells, reptile teeth, fish scales, and three species of gastropods were recorded from this site. A similar fauna was found at site K-3 although the material there is not as abundant as at site K-1. Both of these sites are deemed to be of major significance. It is recommended that these areas be surveyed in more detail and that large collections be made of the fossil material.

Small fragments of fossil bone and fish scales were found in a coarse sandstone or gravel at sites K-4, K-5, and K-6. Exposures of this gravel occur over a large part of the lease area and represent the lower part of the Kaiparowits Formation. These gravels should be investigated in more detail as there is a good chance that fossil mammals will be found in them.

The two fossil wood sites (one in the Kaiparowits Formation and the other in the Wahweap Sandstone) are of little importance. A large palm(?) leaf was found at site K-2 in the Wahweap Sandstone and it may be desirable to obtain this specimen for display purposes, possibly in the Fourmile Bench Plant Office.

In summary, fossil vertebrates were found to be relatively abundant in the Kaiparowits Formation on the Fourmile Bench Site and additional survey and collection of material is recommended. The Wahweap Sandstone was found to be sparsely fossiliferous, although additional survey may reveal more fossil sites.

Nipple Bench Site (Fig. 2): Two geologic formations are exposed on the Nipple Bench Site. The Wahweap Sandstone covers all of the upper plateau surface, while Straight Cliffs Sandstone is exposed of canyon bottoms within the southern impact area.

Fossil vertebrates and plants were found at three sites (K-7, K-8, K-9) on the lease area and all occur in the Wahweap Sandstone (see Fig. 2, and Appendix XIII). Sites K-7 and K-8 are deemed to be of major importance and additional survey and collection is recommended at these sites. Fragments of turtle shells and dinosaurs were abundant at both localities. There is also an excellent chance that fossil mammals will eventually be discovered at these sites. Several crocodile teeth were also observed at site K-7.

Only a few bone and wood fragments were found at site K-9, although this area was surveyed for only a few minutes and additional survey will probably reveal more material.

It is important to note that only three areas on the Nipple Bench Site were surveyed and all were found to contain fossil remains. It is thus very probable that additional survey of this site will reveal many more fossil localities.

In summary, it is highly recommended that additional paleontological survey be undertaken on the Nipple Bench Site and that samples of the fossil material be collected for study and preservation.

Associated Facilities and Access Roads: Because of time limitations it was not possible to survey the pump station sites or associated access roads for the plant sites. The northern pump station will be located on Straight Cliffs Sandstone and the southern pump station on Entrada Sandstone. It would appear from the literature survey that impact on these formations would be low, although it would be desirable to survey these areas before construction begins.

The following formations will be crossed by the water supply pipeline from the southern pumping station to the northern pumping station: Entrada Sandstone, Morrison Formation, Dakota Sandstone, Tropic Shale, and Straight Cliffs Sandstone (respectively). Impact on these areas is deemed to be low based on the literature survey. It would be desirable to confirm this assumption with a field survey.

Mines

Of the three mine sites designated, only the westernmost one (#3) could be located. A plant impression was found in the coal bed at this site and it would be desirable to have a paleobotanist spend some time there and make additional collections of this material. The two eastern mine sites (both #1's) should also be surveyed by a paleobotanist before initiation of mining activities.

Transmission Lines

Kaiparowits Power Plant to Eldorado 500KV Line: The proposed route for this transmission line was surveyed by helicopter on August 6, 1974. The formations which will be crossed by the line are listed in Appendix XI and the environment of deposition, age and fossils present are given along with an estimate of the impact that the line will have on each formation.

From the Fourmile Power Plant the line will extend south-southwest, parallel the Cockscomb Monocline and pass, for the most part, through Cottonwood Canyon. The impact to the formations which it will lie on (Kaiparowits thru Moenkopi) is considered low in all but two cases (Kaiparowits and Wahweap it is considered medium-high).

From the southern edge of the Cockscomb Monocline to Nevada the transmission line will lie for the most part on the Moenkopi Formation and to a less extent on the upper surface of the Kaibab Formation. The impact on the former is considered as medium and on the latter as low. At the Hurricane Fault the line crosses small exposures of Kaibab-Toroweap-Coconino-Supai and Redwall, but only for a short (1/2 mile) distance. These formations are exposed on the eastern (up thrust) side of the fault while the western (down thrust) side is made up of Moenkopi sediments. Between St. George and the Hurricane Hills there are some Pliocene (?) basalts overlying the Moenkopi Formation. West of St. George and the Virgin River the line again crosses small exposures of Moenkopi-Kaibab-Toroweap-Coconino-Supai and Redwall, but none of these appear to be of major paleontological significance.

Of the formations crossed by this transmission line in Utah and Arizona only the Moenkopi Formation will be noticeably affected by impact. A list of the fossil fauna recorded from the Moenkopi Formation is given in Appendix X. Although several exposures of Moenkopi occur between the Hurricane Hills and the Cockscomb Monocline none of the exposures examined which will be crossed by the lines contain paleontological resources deemed to be of major significance. Extensive exposures of the Moenkopi Formation occur just west of the Hurricane Fault and these may warrant further investigation. We had an opportunity to survey these exposures for about 45 minutes and did find a small bed of pelecypods (clams). These are not considered of major significance, although we hasten to add that the exposures are extensive in this area and we sampled only a small portion of them.

In summary, it is deemed that there will be very low impact on the geological formations and paleontological resources crossed by the Kaiparowits to Eldorado Transmission Line.

Kaiparowits Power Plant via Moenkopi Substation to Mohave: The geologic formations which will be crossed by this transmission line are listed in Appendix XII and the environment of deposition, age and fossils present are given along with an estimate of the impaction that the line will have on each formation.

This route was not surveyed by paleontologists and the estimate of impaction on each formation is based solely on the literature survey. These impaction estimates can only be regarded as tentative at this time and it would be desirable to field-survey this route by helicopter before initiation of construction activities.

Outline of Recommended Additional Work

The Phase I field-survey has revealed the presence of an abundance of paleontological resources on the proposed Fourmile Bench and Nipple Bench Plant Sites. Fossil plants were also found to occur at the #3 mine site and fossil shells were found in Moenkopi exposures which will be crossed by the Kaiparowits to Eldorado transmission line.

Both #1 mine sites and the Kaiparowits to Mohave transmission line corridor were not checked by field-survey. The literature survey has shown that fossils are recorded from all formations which occur on the proposed plant sites, associated facilities sites, sites for access roads, mine sites, and areas to be crossed by the transmission lines.

Because of the short time (4 days) spent in the field it is difficult to adequately assess the true significance of the paleontological resources which were encountered. To do this will require additional field-survey with emphasis on locating fossil sites and determining the abundance and diversity of the faunas and floras (Phase II Survey). After this is done it will be possible to outline recommendations for a full scale salvage program (Phase III Salvage).

Phase II Survey: It is recommended that the following additional field-survey be undertaken before initiation of a salvage program:

I. That four paleontologists spend five days (twenty man days) at each of the following sites:
    1) Fourmile Bench Site
    2) Nipple Bench Site
    3) Moenkopi exposures in Hurricane Hills just east of St. George, Utah

II. That two paleontologists (including one paleonbotanist) spend two days each (four man days) at each of the three mine sites.

III. That the Kaiparowits Power Plant via Moenkopi Substation to Mohave Transmission Line corridor be surveyed by helicopter by two paleontologists.

The Phase II Survey is organized for the purpose of making a precise assessment of the paleontological resources on an area. Emphasis is placed on locating fossil sites, determining the abundance and diversity of the faunas and/or floras, and making sample collections of these materials to aid in determining the significance of these resources.

A proposal and cost estimate for a Phase II Survey can be supplied by the Department of Geology, Museum of Northern Arizona at the request of SCE officials.

Phase III Salvage: Depending upon the findings of Phase II Survey it may be necessary to organize a program to collect large samples of fossils from different localities for the purpose of study, preservation and eventual publication. If paleontological resources are deemed to be abundant on an area it will be desirable to obtain good samples of these faunas before they are destroyed by construction activities or disturbed by impaction.

A Phase III Salvage proposal and cost estimate can be drafted only after completion of a Phase II Survey program.

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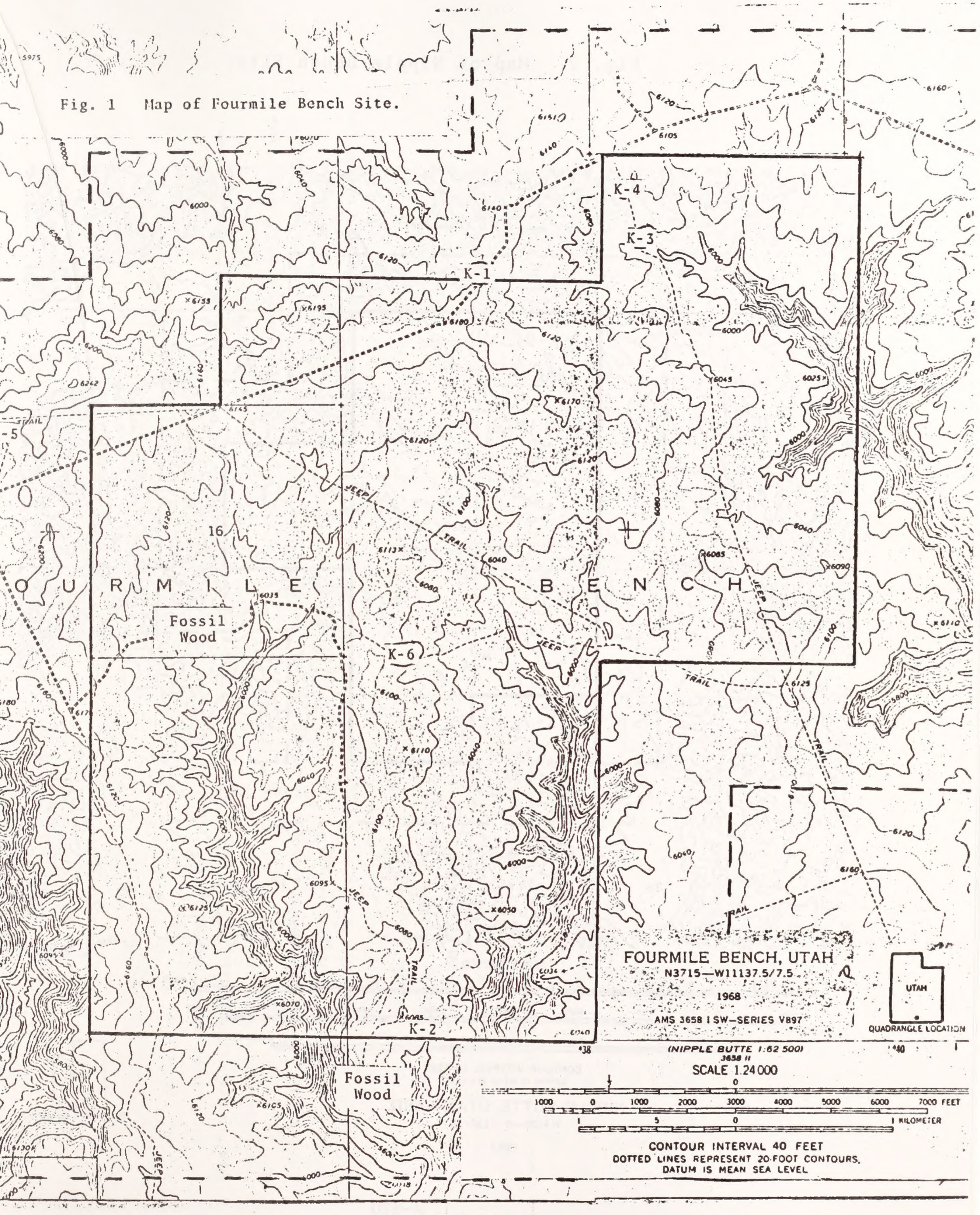
Fig. 1 Map of Fourmile Bench Site.



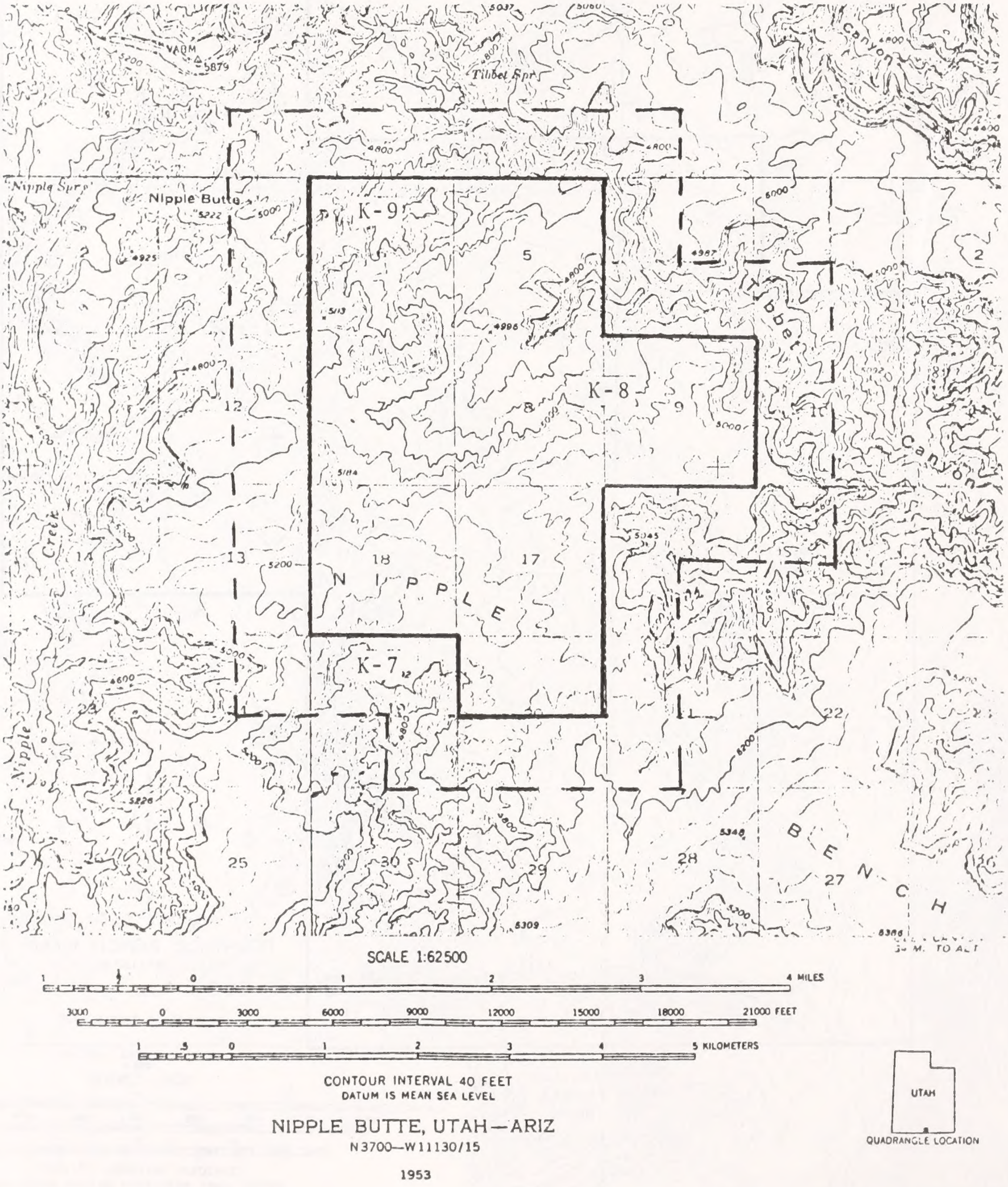


Fig. 2 Map of Nipple Bench Site.

Appendix I

Fossil fauna recorded from Kaiparowits Formation. Data from Gregory (1931, 1950). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

*Campeloma sp.
*Goniobasis sp.
*Physa sp.
Planorbis?
*Unio (5 species)
*Viviparus (3 species)

Vertebrates

Dinosaurs
    *Triceratops sp.
    *Anatosaurus sp.
    Nodosauridae
    Therepoda
Crocodilia
Chelonia
    Basilimys sp.
    Adocus sp.
    *Baena sp.
    Trionychid

Appendix II

Fossil fauna and flora recorded from Wahweap Sandstone. Data from Gregory (1950, pp. 107-108).

Fossils scarce - "Those from unquestioned Wahweap strata include species of dinosaur (?) and turtle (?) bones, many well preserved impressions of leaves, and (invertebrates) Neritina, Viviparus, and Physa..." (Gregory 1950, pp. 107-108).

Appendix III

Fossil fauna recorded from Straight Cliffs Sandstone. Data from Gregory (1950, p. 107). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

Admetopsis sp.
Anomia sp.
*Barbatia sp.
Campeloma sp.
*Cardium sp.
Cerithium sp.
*Chemnitzia sp.
Corbula sp.
Cyrena sp.
Fusus sp.
Glauconia sp.
*Gyrodes sp.

*Inoceramus sp.
*Mactra sp.
*Membranipora sp.
Neritina sp.
Nucula sp.
Ostrea (2 species)
Physa sp.
*Plicatula sp.
Planorbis sp.
*Turitella sp.
Turbonilla sp.
*Volsello sp.
Viviparus (2 species)

Vertebrates

"Bones of Vertebrates"

Appendix IV

Fossil fauna recorded from Tropic Formation. Data from Gregory (1931, 1950). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

*Acanthoceras sp.
Admetopsis sp.
Anatina sp.
*Anchura (2 species)
*Anomia sp.
Baculites sp.
Barbatia sp.
Buchiceras sp.
*Camptonectes sp.
Cardium sp.
*Corbula (3 species)
Cyrena (2 species)
Eulimella sp(?)
Exiteloceras sp.
*Exogyra (2 species)
Fusus sp.
Gloconia sp.
*Gryphea (2 species)
Helioceras sp.
*Inoceramus (3 species)

Legumen sp.
*Lima sp.
Lidpistha (2 species)
Lucina (2 species)
*Lunatia (2 species)
Mactra (2 species)
Metoicoceras sp.
*Modiola sp.
Nemodon sp.
*Ostrea (3 species)
Placenticeras sp.
Plicatula sp.
*Serpula sp.
Sigaretus sp.
Tellina sp.
Tritonium sp.
*Turritella (2 species)
*Veniella sp.
Volsella (2 species)

Appendix V

Fossil fauna and flora recorded from Dakota Sandstone. Data from Lexicon of Geologic Names (1960, p. 1035); and Waage' (1959, pp. 13-26).

"Fossils not common in lower part, but plant remains include coniferous wood, cycadeoids, charophytes and other algae and foliage of ferns and cycods; animal remains include dinosaur bones, fresh-water molluscs, ostracods, and brachiopods".

"Fossils in marginal marine beds include dicotyledonous leaves, wood, false trunks of Tempskya, some fresh-water clams, linguloid, brachiopods, and foraminifera. Marine beds contain pelecypods, gastropods, Linguloid brachiopods, foraminifera, bones of fish, crocodiles and plesiosaurs".

Appendix VI

Fossil fauna and flora recorded from Morrison Formation. Data from Mook (1916, pp. 126-149). (Note: Much work on the fauna has been done since this faunal and floral list was compiled. A major library effort will be need to compile a more updated list). (Also see Breed 1968).

Flora
- Cycadella (11 species)
- Araucarioxylon sp.(?)
- Pindxylon sp.(?)

Invertebrates ("Invertebrate fauna is exclusively fresh-water in character").
- Pelecypoda
  - Unio (10 species)
- Gastropoda
  - Limnoea (3 species)
  - Planorbis sp.
  - Vorticifex sp.
  - Valuata sp.
  - Viviparus sp.
  - Lioplacodes sp.
  - Neritina sp.
  - Valvata sp.
- Ostracoda
  - Metacypris (2 species)
  - Darwinula sp.
  - Cypris (3 species)
- Arundel Forms
  - Bythinia sp.
  - Viviparus (2 species)
  - Cyrena sp.

Vertebrates

- Mammalia
    - *Allodon* (2 species)
    - *Asthedon* sp.
    - *Dryolestes* (5 species)
    - *Ctenacodon* (3 species)
    - *Dicrocynodon* sp.
    - *Docodon*
    - *Ennacodon* (2 species
    - *Paurodon* sp.
    - *Stylacodon* (2 species
    - *Laodon* sp.
    - *Priacodon* sp.
    - *Menacodon* sp.
    - *Tinodon* (3 species)
    - *Triconodon* sp.

Aves

- *Laopteryx* sp.

Reptilia

- Sauropoda
    - *Astrodon* sp.
    - *Dystrophaeus* sp.
    - *Atlantosaurus* (2 species)
    - *Camarasaurus* (2 species)
    - *Caulodon* (2 species)
    - *Apatasaurus* (2 species)
    - *Morosaurus* (5 species)
    - *Amphicoelias* (3 species)
    - *Symphyrophus* sp.
    - *Epantherias* sp.
    - *Diplodocus* (3 species)

- *Apatosaurus* sp.
- *Brontosaurus* (2 species)
- *Pleurocoelus* (3 species)
- *Barosaurus* (2 species)
- *Elosaurus* sp.
- *Haplocanthosaurus* (2 species)
- *Brachiosaurus* sp.

Theropoda

- *Dryptosaurus* sp.
- *Hypsirophus* sp.
- *Allosaurus* (2 species)
- *Creosaurus* (2 species)
- *Antrodesmus* (2 species)
- *Coelurus* (3 species)
- *Tichosteus* (2 species)
- *Ceratosaurus* sp.
- *Ornitholestes* sp.

Predentata

- *Stegosaurus* (9 species)
- *Diracodon* sp.
- *Hoplitosaurus* sp.
- *Camptosaurus* (6 species)
- *Laosaurus* (3 species
- *Dryosaurus* sp.
- *Macelognathus* sp.

Appendix VI (cont'd)

- *Apatadon* sp.
- *Brachyrophus* sp.

Rhyncocephalia

- *Opisthias* sp.

Crocodilia

- *Goniopnolis* (3 species)

Chelonia

- *Compsemys* sp.

Pterosauria

- *Dermodactylus* sp.

Pisces

- *Ceratodus* (3 species)

Appendix VII

Fossil fauna of Entrada Sandstone. Data from Baker, Dane, and Reeside (1936, p. 8).

"No fossils are known from the Entrada Sandstone except dinosaur footprints in the Moab Tongue at a locality 15 miles north of Moab, Utah".

Appendix VIII

Fossil fauna of Carmel Sandstone. Data from Gilully and Reeside (1927). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

- ***Astarte* sp.
- **Camptonectes* (5 species)
- **Cardinia* sp.
- **Cardioceras* sp.
- *Corbula* sp.
- *Cyprina* sp.
- *Dentalium* sp.(?)
- **Dosinia* sp.
- **Eumicrotis* sp.
- *Gervilia* sp.
- *Lima* sp.
- *Lyosoma* sp.
- **Modiola* (3 species)
- *Neritina* sp.
- **Ostrea* sp.
- **Pentacrinus* sp.
- *Pholadomya* sp.
- *Pinna* sp.
- *Pleuromya* sp.
- *Plicatula* sp.
- **Rhynchonella* sp.
- *Serpula* sp.
- *Tancredia* sp.
- **Trigonia* (4 species)

Appendix IX

Fossil fauna recorded from Navajo Sandstone. Data from Brady (1935, 1936), Camp (1936), Breed (1968), and Galton (1971).

Vertebrates

Dinosaurs
- *Segisaurus* sp.
- *Ammosaurus* sp.
- Tracks

Invertebrates

Ostracods

Plant Material

Appendix X

Fossil fauna recorded from Moenkopi Formation. Data from McKee (1954).

Marine Fossils

Pelecypods

- *Pleurophorus* sp.
- *Schizodus* sp.
- *Bakewellia* sp.
- *Auiculopecten* sp.
- *Myalina* sp.
- *Pseudomonotis*(?) sp.
- *Monotis* sp.
- *Myophoria*(?) sp.

Ammonites

- *Meeuoceras* sp.
- *Tirolites spinosus*
- *Cordillerites* sp.
- *Hungarites*(?) sp.
- Orthoceratids

Crinoids

- *Isocrinus* sp.

Crustaceans

- *Halicyne* sp.
- Ostracods

Appendix X (cont'd)

Gastropods

- *Pleurotomaria* sp.
- *Natcopsis*(?) sp.

Worms

Non-Marine Fossils

Vertebrates

- Fishes
  - Paleoniscids
  - Dipnoans
  - Sharks
- Amphibians
  - *Metoposaurus frassi*
  - *Stanocephacosaurus birdi*
  - *Cyclotosaurus randalli*
  - *Rhadalognathus boweni*
  - *Aphaneramma*(?) sp.
  - *Capitosaurus*(?) sp.
  - *Parotosaurus peabodyi*
- Reptiles
  - *Anisodontosaurus greeri*
  - *Arizonasaurus babbitti*
  - Chirotherium tracks

Appendix (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaiparowits	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish, Molluscs, Gastropods, Wood, Plant Remains	Medium-High
Wahweap	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Retpiles, Fish, Fresh-water Gastropods, Ostracods, Pelecypods	Medium-High
Straight Cliffs	Fluvial, Near-shore, Marine	Upper Cretaceous	Vertebrate remains, Marine Invertebrates, Wood, Plant remains	Low
Tropic	Marine	Upper Cretaceous	Marine Invertebrates	Low
Dakota	Flood Plain, Fluvial, Lacustrine, Near-shore, Marine	Upper Cretaceous	Dinosaur and other Reptiles, Fresh-water Invertebrates, Plant remains	Low
Entrada	Aeolian	Jurassic	Dinosaur tracks	Low
Carmel	Nearshore Marine, Marginal Terrestrial	Jurassic	Marine Invertebrates	Low
Navajo Sandstone	Aeolian	Triassic Jurassic	Dinosaurs, Dinosaur tracks, Plant remains, Ostracods	Low
Kayenta Sandstone	Fluvial	Triassic	Dinosaur and other Reptiles, Dinosaur tracks	Low
Wingate Fm.	Aeolian	Triassic	Reptiles, Fish	Low

Appendix XI

The following charts contain the rock layers (formations) that will be crossed by the transmission lines going from the Kaiparowits Power Plant to Eldorado (Northern Route). The environment of deposition, age and fossils present are given along with an estimate of the impact that the lines will have on each formation.

Appendix (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Chinle Fm.	Fluvial	Triassic	Dinosaur and other Worm Trails, Anthropods, Reptiles, Fresh-water Molluscs, Petrified wood, Plant remains, Amphibians, Fish, Ostracods, Branchiopods	Low
Moenkopi	Fluvial in east	Triassic	Reptile tracks, Molluscs, Amphibians, Fish	Low
	Fluvial, Marine to west	Triassic	Molluscs (Ammonites, Snails, Clams & Nautiloids)	Medium

Appendix I (cont'd)

PALEOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaibab Limestone Toroweap Fm.	Marine	Permian	Fish, Molluscs, Bryozoan, Sponges, Trilobites, Corals, Worms, Crinoids, Echinoids, Algae	Low
Coconino Sandstone	Aeolian	Permian	Reptile tracks, Invertebrate tracks	Low
Hermit Shale	Fluvial	Permian	Insects, Plant remains	Low
Supai Fm.	Fluvial, Marine	Permian-Pennsylvanian	Plant remains, Amphibian and Reptile tracks, Molluscs to the west	Low
Redwall Limestone	Marine	Mississippian	Molluscs, Corals, Trilobites, Crinoids, Bryozoans, Blastoids, Foraminifers, Fish, Ostracods	Low

Appendix (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaiparowits	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish Molluscs, Gastropods, Wood, Plant Remains	Medium-High
Wahweap	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish Fresh-water Gastropods, Ostracods, Pelecypods	Medium-High
Straight Cliffs	Fluvial, Near-shore, Marine	Upper Cretaceous	Vertebrate remains, Marine Invertebrates, Wood, Plant remains	Low
Tropic	Marine	Upper Cretaceous	Marine Invertebrates	Low
Dakota	Flood Plain, Fluvial, Lacustrine, Near-shore, Marine	Upper Cretaceous	Dinosaur and other Reptiles, Fresh-water Invertebrates, Plant remains	Low
Entrada	Aeolian	Jurassic	Dinosaur tracks	Low
Carmel	Nearshore Marine, Marginal Terrestrial	Jurassic	Marine Invertebrates	Low
Navajo Sandstone	Aeolian	Triassic Jurassic	Dinosaurs, Dinosaur tracks, Plant remains, Ostracods	Low
Kayenta Sandstone	Fluvial	Triassic	Dinosaur and other Reptiles, Dinosaur tracks	Medium
Wingate Fm.	Aeolian	Triassic	Reptiles, Fish	Low

Appendix XII

The following charts contain the rock layers (formations) that will be crossed by the transmission lines going from the Kaiparowits Power Plant via Moenkopi Substation to Mohave. The environment of deposition, age and fossils present are given along with an estimate of the impact that the lines will have on each formation.

Appendix (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Chinle Fm.	Fluvial	Triassic	Dinosaur and other Worm Trails, Anthropods, Reptiles, Fresh-water Molluscs, Petrified wood, Plant remains, Amphibians, Fish, Ostracods, Branchiopods	Medium
Moenkopi	Fluvial in east	Triassic	Reptile tracks, Molluscs, Amphibians, Fish	Medium

Appendix XII (cont'd)

PALEOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaibab Limestone Toroweap Fm.	Marine	Permian	Fish, Molluscs, Bryozoan, Sponges, Trilobites, Corals, Worms, Crinoids, Echinoids, Algae	Medium
Coconino Sandstone	Aeolian	Permian	Reptile tracks, Invertebrate tracks	Low
Hermit Shale	Fluvial	Permian	Insects, Plant remains	Low
Supai Fm.	Fluvial, Marine	Permian-Pennsylvanian	Plant remains, Amphibian and Reptile tracks, Molluscs to the west	Low
Redwall Limestone	Marine	Mississippian	Molluscs, Corals, Trilobites, Crinoids, Bryozoans, Blastoids, Foraminifers, Fish, Ostracods	Medium
Temple Butte Limestone	Fluvial, Marine	Devonian	Armored Fish	Low
Muav Limestone	Marine	Cambrian	Trilobites, Sponges, Cystids, Gastropods	Low
Bright Angel Shale	Marine, Nearshore	Cambrian		Low
Tapeats	Littoral	Cambrian		Low

Appendix XIII

(To accompany Figs. 1 and 2)

The following list of localities (K-1 to K-9) represent those sites within the lease area or impact parimeter of the two proposed plant sites (Fourmile Bench Site-Fig. 1; and Nipple Bench Site-Fig. 2) where fossil material was either observed or collected. A list of the fossils thus far recorded from each locality is given. The reference numbers (eg. K-1) refer to field notes of Mr. Larry G. Marshall, Senior Paleontologist in charge of Phase I reconnaissance survey of these areas from August 5 to August 8, 1974. Field notes are on file in the Geology Department, Museum of Northern Arizona, Flagstaff.

Fourmile Bench Sites (Fig. 1)

K-1. Kaiparowits Formation. Just northwest of road approximately 30 yards north of SCE stake K-P-4, LS-3103. The matrix is a gray-green mudstone. Fragments of dinosaur bone, turtle shells, gar scales (*Lepisosteus* sp.), a reptile tooth, fish scales (not gar), and three species of gastropods (*Campeloma* sp., *Goniobasis* sp., and *Planorbis* sp.) were collected from this site. Fragments of fossil wood were also found in this area.

K-2. Wahweap Sandstone. Very fine, buff colored sandstone which forms cliff along top edge of canyon. A large palm(?) leaf

was found here and the specimen measures 6 feet long and 3 1/2 feet wide. Fragments of this leaf were collected and the specimen was photographed. Pieces of fossil wood also occur in this area.

K-3. Kaiparowits Formation. Badland area of gray-green mudstones which are exposed along cliffs in amphitheatre on west side of road. Fossil wood, reptile bone fragments, gastropods, and fish scales were observed here.

K-4. Kaiparowits Formation. Coarse sandstone to conglomerate lenses are exposed on west side of road. These contain small fragments of reptile bone and fish scales.

K-5. Kaiparowits Formation. Coarse sandstone to conglomerate lenses occur in this area. These contain fragments of bone and fish scales.

K-6. Kaiparowits Formation. Coarse sandstone to conglomerate lenses occur in this area (similar if not identical to K-4 and K-5). Plant impressions and bone fragments are present.

Nipple Bench Site (Fig. 2)

K-7. Wahweap Formation. Coarse sand to gravel lenses which represent fresh-water channel deposits occur at this site in the uppermost cliff face. Large reptile bone fragments (some up to one foot in length) and crocodile teeth were observed to be abundant in these deposits. The channel deposits are lenticular but extend discontinuously along the entire cliff face. The impression of a leaf was found in a mudstone bed between two of these channel deposits.

K-8. Wahweap Formation. Fossil wood and bone fragments are abundant in this area. A small reptile tooth was collected from an anthill, and turtle and dinosaur bone fragments were also collected. There are channel deposits rich in bone as at site K-7, although here they occur as eroded caps on the hillocks which occur abundantly over the ground surface.

K-9. Wahweap Formation. Wood and bone fragments were observed coming out of a yellowish-green mudstone on the crest of a knoll at this site.

APPENDIX III - 12

The Kaiparowits Project and its Impact on Growth in the Arizona and California Service Areas

APPENDIX III - 12

ENVIRONMENTAL IMPACT STUDY FOR THE BUREAU OF LAND MANAGEMENT

THE KAIPAROWITS PROJECT AND ITS IMPACT ON GROWTH IN THE ARIZONA AND CALIFORNIA SERVICE AREAS

Prepared by: Dr. Alan J. Wyner, Project Director -
Ph.D., Political Science, University
of California at Santa Barbara

Dr. Robert Welsh and Dr. John Gruhl,
Research Assistants - Graduate students
(Doctoral candidates in Political Science)
at the University of California at
Santa Barbara

Arizona Section
Originally Prepared by: Dr. Keith Pearson - Professor of Anthropology
at Northern Arizona University.

Mr. S. Craig Whitney - Graduate Student in
Political Science at Northern Arizona
University

September 21, 1974

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PREFACE

This report discusses some of the likely impact of the Kaiparowits Project on the service areas of the utilities that will receive electricity from the Project. The utilities are located in the states of Arizona and California: Arizona Public Service, Salt River Project, Southern California Edison, and San Diego Gas and Electric. The questions of whether the Project should be approved and the impact of the increased electricity on the utilities themselves are not of concern here. The primary interest of this report is with the likely impact of the increased electricity on the process of growth and urbanization in the service areas. And even more specifically the focus will be on three aspects of urban life as indicators of overall impact: open space (parks and recreation), pollution, and transportation.

The assumption is made that any population growth in the service areas will probably contribute to the already noticeable urban sprawl (actually suburban sprawl) in these areas. The report spends considerable time explaining the nature of the people, their governmental jurisdictions, and the likely population growth patterns in the service areas. In order to understand the impact of any continued growth some awareness of these features is a necessity. The report shows how different forecasts of future population growth rates affects both the need for more electricity as well as the services provided in the fields of open space, pollution abatement and transportation.

It is possible to argue that the availability of electricity from the Kaiparowits Project will cause continued growth in the service areas. Or to state the obverse, some have argued that without more electricity growth will not and can not occur once the electric utilities reach their current system capacity. To say the least, this issue is complicated, and no definitive answer can be given here. In addressing this issue one must consider, at a minimum, all alternative sources of energy and their availability and impact on population growth. No evidence has been found to suggest that trends in population growth will be determined by the availability of electricity. There can be no question, however, that the availability of electricity will help influence the pattern of population growth, commercial/industrial growth and facilities such as parks, pollution abatement and transportation in the service areas. For the purposes of this report it will be assumed that population will grow in the service area and any increase in available electricity will facilitate the growth. The impact of this growth on open space, pollution abatement, and transportation is affected by not only the pattern of the growth but electrical energy availability. As the report will show increased electrical energy will be necessary if certain policies in the open space, pollution abatement, and transportation fields are enacted. (A subsequent section details the current status of population forecasts.)

The report is organized into three sections. First, a description of the demographic and governmental characteristics of the service areas is presented; this is coupled with a discussion of projections for population growth and growth in the demand for electricity in the service areas. Second, the three topics of open space, pollution, and transportation are discussed in terms of both the recent history of these issues and current plans for the future in the service areas. Third, a summary and conclusion will discuss the projected impact of continued growth and urbanization in the service areas and the likelihood of problem solving efforts being adopted and being successful.

At the outset an important qualification is in order. The subject dealt with here is extremely complex and it deserves much thought and extensive further research. Nevertheless, by limiting the study to only specified aspects of the entire, potential set of issues certain conclusions can be reached. Data on electricity consumption and forecasts of electricity demand came primarily from the utilities involved in the Kaiparowits Project. Efforts have been made to verify the accuracy of such data whereever possible.

I. Characteristics of Service Area in California and Arizona and Patterns of Electrical Consumption

DESCRIPTION OF SERVICE AREA IN CALIFORNIA AND ARIZONA

Service Area versus Impact Area in Southern California

The impact area is that part of the total SCE and SDG&E service area which will be studied in this report. The impact area consists of Los Angeles, Orange, Riverside, San Bernardino, Ventura and San Diego counties.

Thirteen California counties and even a small part of the state of Nevada lie within the Southern California Edison service area. San Diego Gas & Electric serves almost all of San Diego County and the southern portion of Orange County. The area varies from the mountainous country around the Sierra Nevadas in Inyo and Mono Counties to the dry desert of San Bernardino and Riverside Counties. (See Maps of Service Area and Population Distribution.)

However, it would be an exaggeration to claim that the Kaiparowits Project would exercise a significant impact over the enormity of this entire area. Some of the counties within the service area are sparsely populated, and others are serviced by another utility as well as by SCE. This is reflected in Table 1 which lists the counties serviced by SCE. Only that part of the population serviced by SCE in each county is included. (For example, the population of the city of Los Angeles is not included because the Los Angeles Department of Water and Power serves all of the residents of that city.)

Clearly, the Kaiparowits Project would have a far more significant impact on those counties which represent the largest segments of Edison's total service area. The combined population of the five largest counties within the SCE service area constitutes 93.4% of the total number of people within the service area. This can be seen from the cumulative listing in the Table. These counties -- Los Angeles, Orange, San Bernardino, Ventura, and Riverside -- would be the ones within the SCE service area most likely to be affected by the Kaiparowits Project. In addition, San Diego county, served by San Diego Gas and Electric, would also likely be affected by the project as it, too, represents a sizeable population. Because of the almost perfect correlation between population and the amount of residential kilowatt-hour sales, and because of the high correlation between population and the amount of commercial and industrial kilowatt-hour sales, we can assume that these five counties accounted for roughly the same percentage of SCE's and SDG&E's total electrical demand.

Thus, these six counties will be referred to as the "impact area" for the project (in California) and the study will concentrate on the impact of the Kaiparowits Project on this area.

Table 1

Counties Within the SCE Service Area (1970)*

County	The County's population as a percentage of total population in entire SCE service area		
Los Angeles	56.4	93.4%	Impact Area
Orange	17.8		
San Bernardino	9.6		
Ventura	5.6		
Riverside	4.0		
Tulare	2.4		
Santa Barbara	2.3		
Kern	1.1		
Kings	.4		
Nevada (state of)	.2		
Fresno	.1		
Inyo	.1		
Mono	.1		
Imperial	.003		

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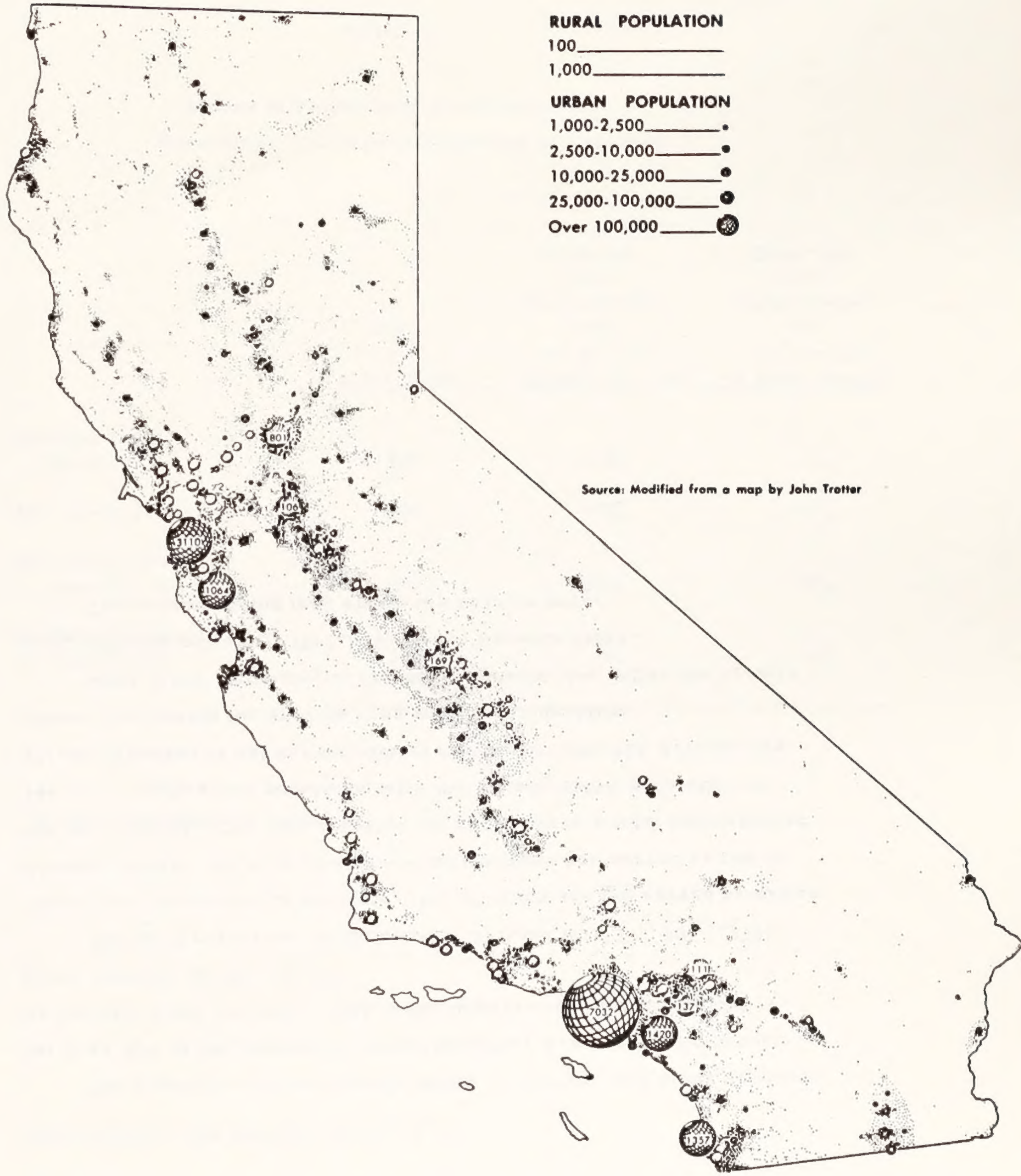
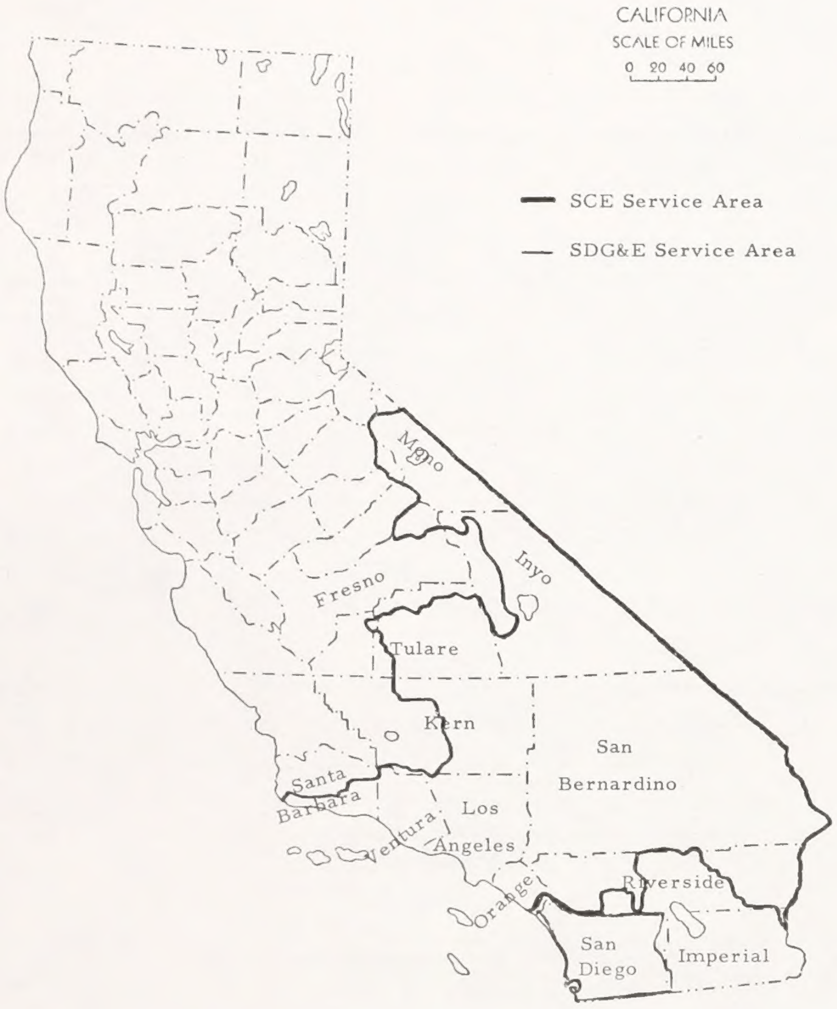
[*] Source: System Forecasts: 1973-1995 (Southern California Edison), p. II-6



Source: Modified from a map by John Trotter



Description of the Arizona Service Area

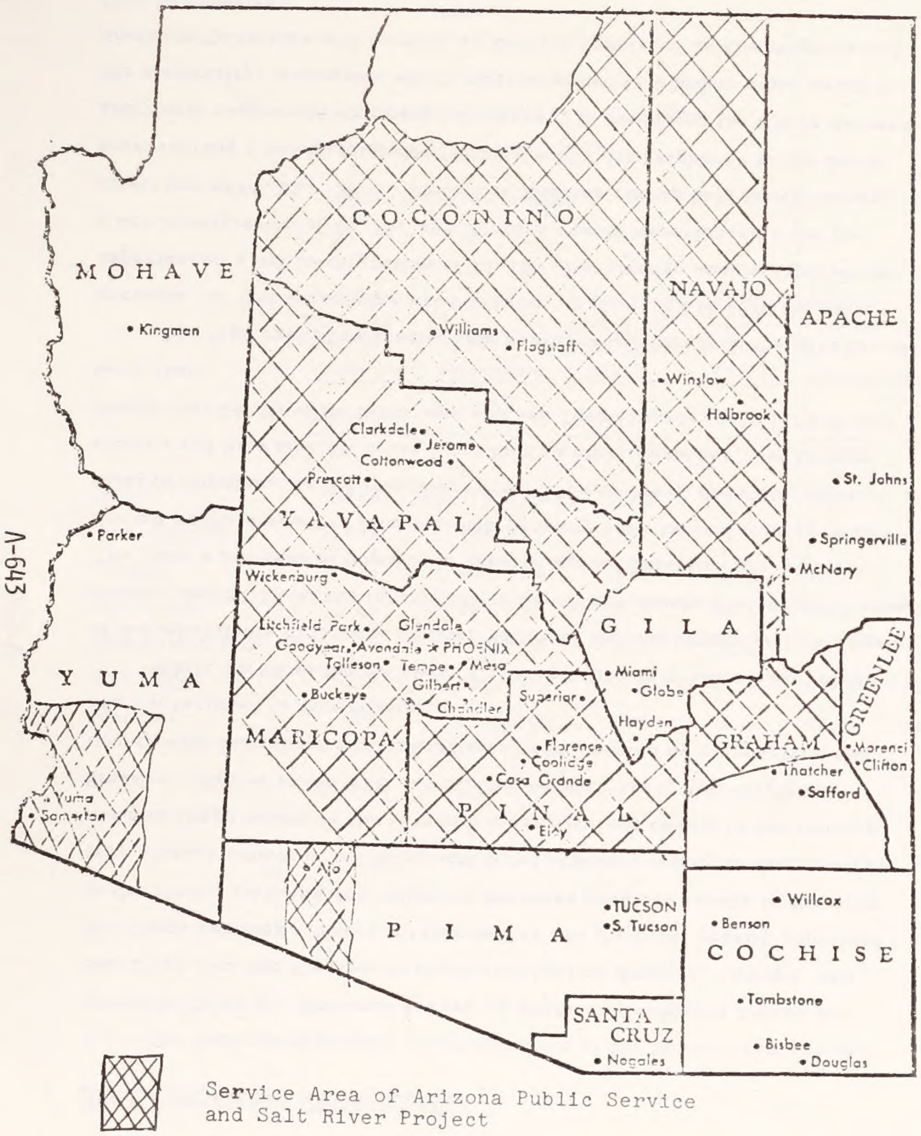
The population of the Phoenix SMSA, Flagstaff, and Yuma accounts for over 80% of the population served by either Arizona Public Service or the Salt River Project. This is the impact area in Arizona that is given attention in this report.

The total population of the state of Arizona is 1, 770, 893 (1970). There are 14 counties in the state, five of which are not served by either Arizona utility. All or part of the other counties are served by one of the two utilities. The five counties not served have a total population of 144, 361. Adding this population with the Tucson SMSA population of 351, 667 (Tucson is not served either) means that 496, 028 Arizona residents live outside the service area under consideration.

Most of the remaining 1, 274, 865 residents live within the service area, with the majority (967, 515) in the Phoenix SMSA.

The accompanying map shows the service area.

County Map of Arizona



▨ Service Area of Arizona Public Service and Salt River Project

Table 1A

Shares of Kaiparowits Electricity as a Percentage of Company Estimates of Demands

	MW from Kaiparowits	Expected from Kaiparowits 1980 as percent of peak demand*	Expected from Kaiparowits 1982 as percent of peak demand*
Arizona Public Service Co.	840	16%	14%
Salt River Project	300	12%	10%
San Diego Gas & Electric Co.	702	22%	19%
Southern California Edison Co.	1,200	7%	6%

---

*Demand estimated by utilities.

CHARACTERISTICS OF SERVICE AREA IN CALIFORNIA

Basic Demographic Characteristics

The basic demographic characteristics of the impact area are presented in Table 2. The area served by Southern California Edison and San Diego Gas and Electric is dominated by Los Angeles, Orange, and San Diego counties. These three counties are the most heavily populated in the state. Los Angeles county is the most populous county in the country; Orange county is the thirteenth most populous county in the country; and San Diego county is the fifteenth most populous county in the country. Smaller counties in the SCE and SDG&E service area, like tiny Mono county with only about 4000 inhabitants, are dwarfed by comparison and are not included in this report.

While 90.9% of the people in California live in urban areas, 98.8% of the inhabitants of Orange county, 98.7% of the inhabitants of Los Angeles county, and 93.5% of the inhabitants of San Diego county live in urban areas. The state's patterns of population density and urbanization are also reflected by the amount of land that has recently been taken out of agricultural production. In the five years from 1964 to 1969, the state experienced a net loss of 3.5% of its farm land to other purposes, but Orange county lost 24.3% of its farm land and San Diego county lost 11.5% of its farm land.

The high rate of migration into Southern California in the past decade accounts for this increasing urbanization. From 1960 to 1970 the state experienced a net in-migration of 13.4%. But Orange county experienced a net in-migration of 78.3%, and Ventura county experienced a net in-migration of 66.2%. Thus, while Los Angeles county held fairly steady, experiencing a net in-migration of only 4.2%, its neighbors to the South and North registered whopping increases. In assessing the future demand for electricity, a question which must be asked is whether other areas in Southern California will become as densely populated as Los Angeles and Orange counties?

Because different types of housing units use different amounts of electricity, housing patterns must also be taken into account when assessing future demand for electricity. Single unit housing uses more electricity than multiple family dwellings. Sixty-seven percent of the people in the state live in one-unit structures. While roughly the same percentage of the inhabitants of Orange and San Diego counties live in one-unit structures, a slightly smaller percentage in Los Angeles county live in one-unit structures. As a county becomes more densely populated, it would be expected that a smaller percentage of people in the county would live in one-unit structures.

Table 2

Demographic Characteristics of Counties

Served by SCE and SDG&E

(Source: 1970 Census)

	population per square mile	1970 population	birth rate per 1000 population (1968)	net migration (1960-1970)	population in urban areas	land in agricultural use
	persons		births	%	%	%
State	128	19,957,715	17.5	13.4	90.9	35.7
Los Angeles	1,730	6,993,371	18.1	4.2	98.7	21.4
Orange	1,817	1,409,359	18.2	78.3	98.8	36.7
Riverside	64	449,878	16.7	36.8	78.6	13.6
San Bernardino	34	672,163	18.1	20.8	89.8	16.4
San Diego	319	1,351,135	17.0	16.4	93.5	22.6
Ventura	203	374,520	17.8	66.2	92.4	36.3

Table 2 (cont'd)

	change in amount of land in agricultural use (1964-1969)	change in farm population (1960-1970)	population in one-unit structures	per capita income
	%	%	%	dollars
State	-3.5	-44.7	67.0	3,614
Los Angeles	-4.7	-61.7	60.6	3,864
Orange	-24.3	-93.6	68.1	3,872
Riverside	-15.2	-51.6	75.1	3,083
San Bernardino	17.8	-37.5	82.0	3,002
San Diego	-11.5	-44.4	67.7	3,381
Ventura	-1.0	-50.4	80.0	3,246

Table 2 (cont'd)

	sex	- race -				median	median
	female	white	black	of Spanish surname	other	age	years educated*
	%	%	%	%	%	years	years
State	50.8	not available				28.4	12.4
Los Angeles	51.6	67.1	10.8	18.3	3.7	29.6	12.4
Orange	50.9	86.0	.7	11.3	2.0	26.2	12.6
Riverside	51.0	75.8	4.6	17.3	2.2	29.7	12.3
San Bernardino	50.6	77.8	4.2	16.0	2.0	26.8	12.2
San Diego	48.2	79.4	4.6	12.8	3.2	25.6	12.4
Ventura	50.3	76.4	1.7	19.6	2.3	25.1	12.4

*of persons 25 and older.

Table 3

Population Growth in Impact Area

1950 - 1970

	1950 population	1970 population	% increase
Los Angeles	4,151,687	6,993,371	68.4
Orange	216,224	1,409,359	551.8
Riverside	170,046	449,878	164.6
San Bernardino	281,642	672,163	138.7
San Diego	556,808	1,351,135	142.6
Ventura	114,647	374,520	226.7
Total	5,491,054	11,250,426	104.8

Population Growth

Table 3 shows that the population in Impact area has more than doubled since 1950. There are many conflicting projections concerning population growth in California; unfortunately it cannot be said that any one of them is clearly more authoritative than the others. However, based on the demographic projections which we have studied, we believe that a birth rate somewhere between 2. 1 and 2. 5 births per woman of childbearing age (between series E and D) is likely, and an annual net migration of 100, 000 into the state appears reasonable.

Projected patterns of population growth throughout the Southern California area are currently in a state of flux. There is no agreement over the extent to which the Southern California population can be expected to grow in the next twenty or thirty years. Due primarily to changing social attitudes concerning the desirable number of children per family and the role of women in society, population projections of only a few years ago have been discarded in favor of projections which reflect these changed attitudes and which consequently project a lower rate of population growth. But current population projections reflect these changing attitudes to differing degrees. In this period of transition, there is considerable variability among the population projections issued by governmental agencies and utility companies.

A growth rate following the "D-100" series assumes a birth rate of 2. 5 births per woman of childbearing age and a net migration of 100, 000 people per year into the state. A growth rate of "E-O" assumes a birth rate of 2. 1 births per woman of childbearing age and a net migration of zero per year into the state.

The following table indicates the series currently being used by the California Department of Finance (DOF), the California Public Utilities Commission (CPUC), the Rand Corporation, the Southern California Association of Governments (SCAG), Southern California Edison (SCE), and the San Diego Gas & Electric Company (SDG&E).

DOF	D-100 is their "baseline" series. They use E-0, D-150, and C-150 as alternative series.
CPUC	CPUC uses a combination of series D and E, varying according to the geographical area. CPUC does not indicate what net in migration it expects.
Rand	In a study dated September, 1972, Rand used the D-150 series, but they are in the process of switching to the E-100 series. (Private communication with Dr. Ronald Doctor, Sept. 10, 1974)
SCAG	SCAG uses a combination of the E-) and D-150 series. (In their terminology this is referred to as a "DE2a" series.) However, SCAG is in the process of switching to another series which is also a combination of the D and E series, but which is closer to the E series than is their DE2a series. (This new series is referred to as their "FEB Delphi" series.)
SCE	SCE uses the E-100 series.
SDG&E	SDG&E uses the D-100 series.

Using these series, the following population projections have been made for the year 1990:

	County					
	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Ventura
DOF (D-100)	7, 347, 000	2, 465, 000	756, 000	914, 000	2, 242, 000	704, 000
DOF (E-0)	6, 571, 000	2, 195, 000	681, 000	826, 000	2, 044, 000	602, 000
SCAG (DE2a)	7, 701, 000	2, 240, 000	765, 000	1, 065, 000		835, 000
SCAG (FEB Delphi)	7, 452, 000	2, 074, 000	700, 000	911, 000		643, 000
SCE (E-100)				917, 000		770, 000
SDG&E (D-100)					2, 242, 000	

CPUC and Rand do not issue county-by-county population projections. The SCAG area does not include San Diego county. The population projections of SCE are based on their service area within a county rather than on the entire county. All of Los Angeles, Orange, and Riverside counties are not within the SCE service area. Therefore the SCE population projections for its service area within these counties are not comparable to the DOF and SCAG population projections, which are for the entire county. However, all of Ventura and San Bernardino counties are within the SCE service area, and therefore SCE's projections for these two counties are comparable to the projections of DOF and SCAG.

As can readily be seen, there is a wide degree of variance between these projections. Compounding the confusion is the fact that different assumptions concerning population distribution within Southern California are apparently being made even when there is agreement concerning the rate of population growth in Southern California. For example, the following population projections for Ventura county for the year 1990 seem to reflect different assumptions concerning the nature of population distribution and net migration:

DOF (E-0)	602,000
DOF (D-100)	704,000
DOF (D-150)	731,000
DOF (C-150)	750,000
SCE (E-100)	770,000

Southern California Edison's E-100 series, which is based on an expected birth rate of 2.1 (the level which in the long run would result in zero population growth) and an expected annual net migration of 100,000 persons into the state, yields a higher projected population than the Department of Finance's E-0 series, which would be expected, but it also yields a higher projected population than the Department of Finance's D-100 series, which would not have been expected. And most perplexing is the fact that SCE's E-100 series yields a higher projected population even than the Department of Finance's C-150 series, which is based on an expected birth rate of 2.8 and an expected annual net migration of 150,000 persons into the state. The Department of Finance's C-150 series is its highest plausible alternative. The discrepancy between the DOF and SCE projections must be due to different assumptions concerning out of state and intra-state migrants within Southern California. Specifically, the discrepancy must be due to different assumptions concerning the extent of migration into Ventura county.

There is a similar, though much less marked, discrepancy for San Bernardino county for the year 1990.

DOF (E-0)	826,000
DOF (D-100)	914,000
DOF (D-150)	927,000
DOF (C-150)	953,000
SCE (E-100)	917,000

The SCE E-100 series yields a higher projected population than does the DOF D-100 series. Again, the Department of Finance and Southern California Edison must be making different assumptions concerning population distribution.

Urban and Suburban Growth

Urbanization is a phenomenon that is quite familiar to contemporary America, and especially to Southern California. The most noticable, and probably the most important, national demographic trend of the post WWII era is the increasing concentration of people in urban areas. This has produced a decrease in the percentage of the population that lives in small towns or rural areas; fewer and fewer people escape the influence of urban life.

Urban areas are characterized by life styles, housing patterns, and work experiences that differ from rural attributes. Urbanites are a highly interdependent group, requiring cooperation of many different people in order that their daily life can proceed; the trucker, grocer, policeman, shoe salesman and many others play a role in determing the nature of an urban residents' life and behavior patterns. By definition urban areas are more densely settled, with people living closer together than in rural areas. The United States Bureau of the Census defines an urban area as any place having at least 2500 people. This definition does not agree with most common sense attitudes about what constitutes an urban place. An urban area is usually felt to be part of a larger metropolitan area. In this report urban refers to communities in a metropolitan region.

Within urban areas there is typically a separation between place of residence and place of employment. Nowhere is this fact of more consequence for both private citizens and those who make public policy than in Southern California. The enormous degree of reliance upon automobiles to move from residence to employment and from residence to necessary goods and services has had a major impact on the character of Southern California. For example, Los Angeles County alone has over 20,000 miles of highways and streets.

In Southern California the urbanization process has been dominated by the desire to sprawl and to avoid the extremely high density living that is found in many other American urban centers. In this sense Southern California has been suburbanizing and not urbanizing. Suburban life has many of the attributes of urban life style mentioned above, but it is usually characterized by a higher percentage of middle and upper income groups with a high percentage of single-family homes and a desire for lower population density than is found in the central city area.

Southern California, especially the Los Angeles area never developed a high density core area surrounding the industry and commercial which provided employment. Los Angeles, epitomized the post-automobile city. It is a region. Spread out over a very large area, both the Los Angeles and San Diego regions have a lower population density (people per square mile) than most metropolitan centers in the nation, despite their large populations. (Los Angeles County covers 4,069 square miles and San Diego is spread over 4,261 square miles.)

Whatever the level of population growth that occurs in Southern California it will contribute to the outward movement; no large scale migrations back into the "downtown" or "central" areas is foreseen. The suburban growth of the last two decades took place into areas that were either agricultural or previously barren but now habitable because of imported water supplies. There is no indication of any change in the pattern of sprawl.

Having just made such a prediction it is appropriate to point out the complexities involved in forecasting trends in urban development. In order to understand urban growth patterns one should study such variables as the location of new growth in relation to existing communities, the type of planning control in the area, the level of quality standards required in new construction, the degree of public subsidies in new urban development and the nature of social class and racial integration. Taking this incomplete list of variables and realizing that each of these variables has several possible values points out the enormous number of logically possible combinations that might represent the form of future urban growth.

In the face of this complexity this report makes some simplifing assumptions. We assume that the suburbanization process of the last few decades in Southern California, characterized by continued suburban sprawl with reliance upon single family housing, will dominate whatever growth occurs in the area. The sprawl, of whatever magnitude, will occur in the midst of relatively unplanned, uncoordinated growth policies with relatively little regional public control over the exact nature of the sprawl.

Governmental Jurisdictions

Within the six county high impact area, responsibility for the performance of local government functions is quite fragmented. In addition to the county governments, numerous cities and special districts exercise jurisdiction. For instance, during the 1971-72 fiscal year in Los Angeles County over 340 special districts performed local government functions. Approximately one half of these districts were governed by the county Board of Supervisors, but the remainder were controlled by separately elected boards of directors. In addition, there are 77 cities within Los Angeles County, each making decisions about the cost of public services and the kind of community life styles that will predominate.

Some cooperation between these governmental entities can be seen. In fact, cooperative arrangements are common and Southern California has been a pioneer in the use of the so-called "Lakewood Plan" whereby independent cities and special districts contract with another governmental entity, usually the County, for the performance of certain services.

Despite the cooperation, the fragmentation of decision making authority within the area means that no coherent, comprehensive plan for future growth is being implemented on an area wide basis. The Southern California Associations of Governments (SCAG) is an association of the counties of Los Angeles, Orange, Riverside, San Bernardino, Ventura, and Imperial and most of the cities within these counties. The San Diego Comprehensive Planning Organization is a similiar group. These regional planning associations have been developing area-wide plans in transportation, open space, population growth forecasting, and other areas. So far very little implementation on a region-wide basis has taken place. Some planning may take place at a regional level, but political control remains highly decentralized and fragmented.

Any discussion of future growth and its impact in Southern California must take into account these facts: fragmented government, some regional planning but little regional implementation of plans, and different local preferences for growth. Some areas within the service areas continue to be receptive to the traditional American growth ethic -- growth is necessary and proper. Other communities have been recently expressing doubt about the inevitability and desireability of continued growth. The clash between these contending viewpoints is probably the major feature of local politics within the impact area under consideration. Some communities may decide to limit or even stop growth and to that extent the suburbanization process will be changed in its rate and character. Although there are some strong anti-growth sentiments in the area, there is no indication that efforts by some localities to control growth more stringently than before will have a major impact on the area in the near term future.

CHARACTERISTICS OF SERVICE AREA IN ARIZONA

The combined service area of Arizona Public Service and the Salt River Project covers most of Arizona and includes Arizona's largest metropolitan area (Phoenix). Tucson is the second largest city in Arizona but it is not served by these utilities. Next to Phoenix, the two largest communities in Arizona served by utilities participating in the Kaiparowits Project are: Yuma and Flagstaff.

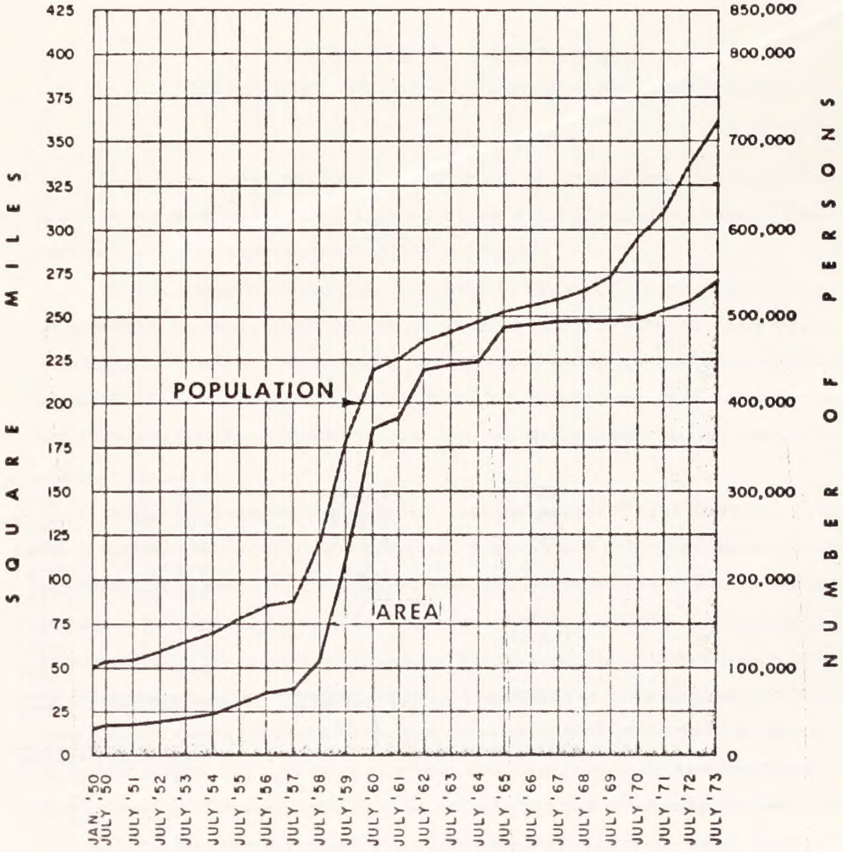
Yuma is located 138 feet below sea level in the extreme southwest corner of the state. The city was officially established in 1854, but its history goes back to the Spanish conquistadores and missionaries. Its principle economic activities are agriculture, livestock, tourism, light industry, and it is the seat of Yuma county government. There has been a 21% population increase from 23,974 in 1960 to 29,007 in 1970. Yuma is rapidly becoming a city in which agricultural enterprises are being replaced by industrial concerns.

Flagstaff is the hub of trade and economic activity for northern Arizona. It is located in the pine forested area of northcentral Arizona. Lumbering, tourism, retail and wholesale trade, and education make up its economic base. Flagstaff was incorporated as a town in 1894 and as a city in 1928. There has been tremendous growth since 1950. The city's population rose from 18,214 in 1960 to 26,117 in 1970, an increase of 43.4%.

Phoenix was not the most important urban center in Arizona until it became the capital city of the Territory in the late 19th century. After that the city experienced continued rapid growth. Today, Phoenix has a population of over 743,000. With a total city area of 269 square miles, its population density comes to 2,687 persons per square mile. This figure is rather misleading, however, for much of this land area is vacant. One of the largest city parks in the nation, South Mountain Park, covers 16,000 acres of the total land area. See Chart 1.

Chart 1

PHOENIX GROWTH



YEAR	POPULATION NO. OF PERSONS	AREA SQUARE MILES
JANUARY 1, 1950	102,548	16.4
JULY 1, 1950	107,116	17.1
JULY 1, 1951	108,158	17.1
JULY 1, 1952	119,000	18.9
JULY 1, 1953	129,956	21.0
JULY 1, 1954	140,062	24.1
JULY 1, 1955	155,788	29.0
JULY 1, 1956	170,082	35.7
JULY 1, 1957	172,569	36.3
JULY 1, 1958	241,899	52.6
JULY 1, 1959	360,771	110.0
JULY 1, 1960	439,671	187.4
JULY 1, 1961	451,964	191.1
JULY 1, 1962	468,385	220.3
JULY 1, 1963	482,521	222.6
JULY 1, 1964	494,061	222.7
JULY 1, 1965	504,448	245.7
JULY 1, 1966	511,238	246.2
JULY 1, 1967	519,006	247.4
JULY 1, 1968	527,774	247.7
JULY 1, 1969	546,381	247.7
JULY 1, 1970	589,374	247.9
JULY 1, 1971	620,750	254.9
JULY 1, 1972	674,000	258.2
JULY 1, 1973	723,700	269.3

Table 5

Per Capita Income - Phoenix Area

Year	Amount
1967	$2,934
1968	3,195
1969	3,537
1970	3,841
1971	4,167
1972	4,522
1975 (Projected)	5,217

New Housing Units (All Types), Phoenix

1968	5,741
1969	9,556
1970	9,213
1971	13,769
1972	16,834
1973 (June 30)	7,636

Population of Phoenix (within corporate boundaries only)

Year	Population	Area (Sq. Mi.)	Density
1881	1,708	0.5	3,416
1920	29,053	5.1	5,697
1930	48,118	6.4	7,518
1940	65,414	9.6	6,814
1950	106,818	17.1	6,247
1960	439,170	187.4	2,344
1970	582,500	247.9	2,350
1973	723,700	269.3	2,687

Table 4

Growth of Housing Units by Type, Phoenix Metropolitan Area

Type	1970 Census	1971 Year's End	1972 Year's End	1973 Year's End	Growth Rate 1970-73 (%)
Single Family	231,363	249,037	269,246	277,998	+20.2
Multiple Units	58,564	79,408	93,338	97,583	+66.6
Townhouses/Condomin.	5,630	8,675	13,334	17,129	+204.2
Mobile Homes	21,422	32,700	38,400	41,400	+93.3
Total	316,989	369,820	414,318	434,110	+36.9%

Today a variety of economic factors are important in Phoenix including tourism, electronic appliance manufacturing, government, light industry, retail and wholesale trade, and construction. Phoenix has long offered the business and industrial community of the Southwest an attractive tax structure, making for a large growth in industry during the past two decades. "Open shop," and "right to work" legislation, requiring that no employer in the state restrict employment to union members has helped keep employee salaries and wages relatively low and has helped increase the number of industries attracted to the city of Phoenix. Due to this growth, job opportunities have expanded and per capita income has risen. The unemployment rate in Phoenix (3.7% in 1970) is fairly stable from year to year, usually paralleling the national average.

With the increased urbanization and industrialization of Phoenix the concurrent growth of the nearby surrounding smaller cities was stimulated. By 1970, the Phoenix Standard Metropolitan Statistical Area (SMSA), including the cities of Phoenix, Glendale, Tempe, Mesa and Scottsdale, had a combined total population of 811,373.

According to the 1970 U.S. Census, the Phoenix SMSA had a total population of 811,373. Of this total, 83% (674,590) were classified as white: 13% (107,379) were classified as Spanish language or surname; and 4% (29,404) were classified as blacks. (Other racial categories occurred in such small quantities as to be insufficient to quantify separately.) Although Arizona has a large Indian population most of them live on reservations or in towns in northern Arizona and New Mexico close by the Navaho reservation.

PROBLEMS IN FORECASTING ELECTRICAL ENERGY CONSUMPTION PATTERNS

For illustrative purposes the problem of forecasting electrical demand in the SCE and SDG&E service areas will be examined here. The Arizona utilities experience similar problems.

In assessing consumption forecasts by the participating utilities it is essential to understand that all such predictions are necessarily problematical. There is, at present, no one forecasting methodology employed by all utilities -- or even by most utilities. Therefore, it is not surprising that one may find dissimilar projections being made about essentially similar areas.

Also, all demand projections affect the actual energy demand. That is, if utilities underestimate projected demand and only provide the amount of electricity estimated, actual demand will obviously be curtailed so that it matches that predicted. (An outcome requiring changes and perhaps inconvenience for electrical consumers.) Conversely, if demand is overestimated and increased electricity is available for consumption, utilities may curtail conservation efforts and thereby stimulate demand to the anticipated levels. In a very real sense, demand forecasts are important determinants of actual consumption rather than the other way around. As the Federal Energy Administration has stated, because demand forecasts tend to be self-fulfilling "it is not possible to verify adequately the validity of critical assumptions upon which projections are based."

The problematical character of demand forecasts are even more accentuated due to the changing consumption patterns that have been occassioned by the energy crisis and the resulting increases in the real price of electricity. This has lead residential, industrial, and commercial customers to institute some kind of energy-saving program, be it simply turning off unused lights or replacing some energy intensive machinery with human labor. Regardless of the method used, electricity customers cut their consumption in order to offset rising costs and diminished supplies. This has lead utility forecasters to reduce their prior estimates of demand, although the exact amount of change varies from utility to utility. Clearly, prior projections based on virtually unlimited resource supplies are being scraped in favor of more conservationally-minded estimates. But because the utilities (and the customers) have found themselves in a vastly different situation than that predicted, the precise nature of future demand in a resource-scarce era is still unknown.

Consumption Forecasts for Southern California Edison Service Area

The area served by Southern California Edison is the most heavily urbanized of the participating utilities in the Kaiparowits Project. Prior projections of annual peak demand constructed by SCE were predicated on a growth rate of over 9% in electrical consumption. However, current predictions place the consumption growth rate at a much lower level, somewhere around 5% -- depending upon which current projection is utilized. So dramatic has been the decline in expected consumption growth rates, SCE has prepared two different, although not disparate, forecasts about expected increases in demand. To illustrate the rapidly changing nature of demand forecasting, the following table compares the 1973 estimates concerning consumption in 1983 with the current 1974 forecast:

Projections for 1983

	1973 Forecast	1974 Forecast	% Reduction
Annual Peak Demand	18,990 (MW)	16,300 (MW)	14.1
Residential Per Capita	9,685 (Kwh)	7,795 (Kwh)	19.6
Residential Sales	28,330 (Kwh)	24,140 (Kwh)	12.4
Commercial Sales	29.880 (Kwh)	19,860 (Kwh)	26.3
Industrial Sales	27,350 (Kwh)	22,970 (Kwh)	16.0

(See Figures 1-6 for more complete breakdown.)

Not only do prior projections overestimate long range electricity consumption, SCE projections for 1974 are inflated compared to actual consumption for the first seven months. According to the California Public Utilities Commission, SCE 1972 projections for 1974 averaged over 18% higher than actual consumption. A monthly breakdown on the reduction achieved this year is presented in the following table:

SCE Reduction in Sales Compared to 1972 Projections

	Dec 1973	Jan	Feb	Mar	April	May	June	July
Residential	8.6	15.5	17.5	18.4	16.7	17.2	12.6	6.4
Commercial	13.8	14.4	16.7	19.6	19.1	17.4	17.5	12.7
Total	16.4	13.4	21.7	22.0	20.1	19.3	19.9	10.7

(See Figure 6) (Data on industrial conservation not available)

While these reductions in consumption have been impressive, it is important to note that the total percentage decrease appears to have leveled off or declined somewhat as is shown by the July reduction figures. Furthermore, the latest figures received from SCE show that the total percentage reduction in sales for August 1974 was 11.7% giving additional support to the idea that percentage reductions in consumption has stabilized.

It bears repeating that predictions about future demand based on the experience of the first seven months of this year cannot be considered highly reliable. As yet SCE has not had sufficient time to determine whether these reductions have long range significance or are merely momentary responces to the shortages experienced earlier this year. For example, according to the table presented above, residential conservation has fallen rapidly since the beginning of the summer, indicating that residential customers may be returning to their prior consumption patterns. Commercial customers, on the other hand, have been able to maintain a fairly high level of conservation, which suggests that firms have been able to institutionalize energy saving programs into their daily operations. If these inferences are correct, then it would appear that the residential sector is the most volatile and unpredictable of the three major users of electricity.

Whether or not current consumption reductions will be maintained depends on many variables and assumptions -- only a few of which will be identified here. One of the most important factors is future governmental and utility policy toward conservation. In part the decline in consumption conservation shown above is attributable to a relaxation of the California Public Utility Commission standards on utility conservation programs, moving from mandatory to voluntary compliance. In turn, the utilities have relaxed their customer conservation requirements thereby giving rise to increased consumption. If state and federal agencies resume their strict standards on consumption, one should expect a continued reduction in electrical usage comparable to that achieved so far this year. This is not to say that total kilowatthour sales or peak demand will not increase, but that they will not increase at the rate previously forecast. However, there are a number of mitigating factors which could offset any decrease in consumption due to stringent conservation measures.

First, it has been predicted that during the latter quarter of this century there will be a serious shortage in natural gas, the major competing source of energy, which will result in an increased reliance on electricity and a decline in mixed utility customers. According to SCE predictions, "due to uncertainty of gas supply to large interruptible users, an increasing number of commercial and industrial customers will consider electricity to be a feasible alternative." This prediction is borne out by San Diego Gas and Electric Company forecasts which estimate that unless new reserves of natural gas are discovered soon, they will have to impose a moritorium of all new gas hookups. However, these predictions have been challenged by the Rand Corporation who claim that synthetic gas will replace diminishing natural gas supplies so that gas will remain a competitive energy alternative.

Second, housing patterns and building construction standards affect electrical consumption. It is estimated that apartments and condominiums consume one third less electricity for heating and cooling purposes than do single unit residences. With respect to construction standards, the Federal Energy Administration estimates that the capital outlay required to generate 10 kilowatts of electricity is substantially greater than that required to install proper insulation which would reduce heating/cooling requirements by the same amount. Improved building standards, therefore, would substantially reduce expected demand.

Third, there is expected to be an increasing number of households relative to total population increases. That is, even though population is expected to grow at a lower rate, the size of the average household is expected to decrease thereby creating more households per total population than has traditionally been the case. An increasing household formation rate will mean that there will be an increase in the number of dwellings per population and an increased number of utility customers. Currently, SCE predicts that the average household contains 3.04 persons -- by 1995, this is expected to decline to 2.78 members per household.

Fourth, the availability and use of time-saving electrical appliances is expected to increase. In the residential sector, SCE estimates a moderate growth in appliance saturation -- not only will more households own more electrical appliances, but household members are expected to replace existing appliances with ones which consume greater amounts of electrical energy (eg. from black and white televisions to color sets; from conventional refrigerators to frost free refrigerators; from conventional ovens to self-cleaning ovens). The current level of appliance saturation is subject to varying interpretations. To give some idea of the importance which appliance saturation levels play in estimates of total residential sales, SCE estimates that per capita kilowatthour sales will be 15,939 by the year 2000. The Rand Corporation, on the other hand, only predicts sales to be 11,500, the difference between these two figures largely varying with one's estimation of the appliance saturation levels.

A more accurate picture of consumption patterns in the service area of Southern California Edison can be seen in the electric consumption of the three largest user types -- residential, commercial, and industrial. As the following table indicates, the commercial and residential sectors are expected to increase in their share of total SCE sales, with commercial sales increasing throughout the rest of the century and residential sales leveling off and declining somewhat during the 1990's. Throughout the period industrial sales have steadily decreased from a high of 38% to an expected share of only 23.8% by 1995. The increase in commercial and residential sales and the corresponding decrease in industrial sales indicate that the Southern California area is moving to a more service oriented economy. No doubt part of the reasons for declining industrial sales is due to the more stringent environmental standards which now apply to the Southern California area. The fact that the Federal Energy Administration doubts that the Kaiparowits generating plant could be constructed in Southern California because it could not meet air pollution control standards illustrates the restrictions placed on heavy industry. Only the mining sector (principally oil drilling) is expected to show any substantial increases throughout the rest of the century, for obvious reasons.

Net Edison Kilowatthour Sales
By Customer Classification

(As A Percentage of Total Kilowatthour Sales)

Year	Residential	Commercial	Industrial
1955	19.7	13.2	--
1960	21.0	18.1	38.0
1965	23.7	19.7	36.8
1970	24.3	22.0	35.0
1975	25.4	24.6	32.0
1980	26.4	26.9	26.9
1985	26.9	29.1	25.3
1990	26.4	31.2	24.3
1995	25.4	33.4	23.8

(Estimates for 1975-1995 provided by SCE)

Whether consumption will grow at the rates forecasted cannot be determined. There is great potential for electrical conservation in the commercial and residential sectors but whether such savings will be realized depends upon the complex interplay between governmental and utility conservation policies and customer consumption patterns.

San Diego Gas and Electric

The area served by San Diego Gas and Electric comprises most of San Diego County, an area which is currently one of the fastest growing areas in California. SDG&E predicts a rather substantial influx of new customers during the rest of the century. This is evidenced by the fact that SDG&E still forecasts future population growth on a D-100 series while SCE employs the lower E-100 series.

It is difficult to fully assess SDG&E predictions about future growth because of the particular methodology they employ in determining their future demand. For instance, SDG&E forecasts do no distinguish between industrial and commercial electricity sales. In addition, multi-meter apartment buildings are also included within the commercial sales category, thereby making the commercial classification encompass a wide diversity of economic activities.

Also, while SDG&E has revised their 1974 forecast downward by some 23% over their 1973 predictions, their methodology for accounting for this "conservation factor" is not wholly satisfactory. Their method amounts to subtracting 1284 million kilowatthour from total kilowatthour sales for each year predicted. SDG&E's 1978 demand projections have been reduced by 1284 million kilowatthours just as have been their 1995 projections even though the 1995 total is over twice as large as their 1978 projection. Because of this, one would expect that if 1284 million kilowatthour "conservation factor" is appropriate for 1978, an even larger figure would be more realistic for 1995. However, it must be noted that all utilities are currently faced with consumer behavior which has called into question traditional assumptions about growth and demand.

As has already been stated, SDG&E predicts a substantial increase in electricity demand throughout the rest of the century. But as Figure 7 shows, SDG&E's predictions about population growth does not account for the size of the increase predicted. For example, SDG&E's forecast for 1974 states that 1612 megawatts will be required to meet the demands of a service area comprising 1,528,000 people. If the same megawatt demand per population ratio were maintained for 1985, then the 3612 megawatts predicted would meet the demand of a population of 3,612,000 instead of the 2,000,000 actually predicted. Therefore, SDG&E predicts a very substantial growth in the per capita consumption level. As Figure 8 illustrates, per capita consumption is expected to increase 62% between 1973 and 1985.

Whether or not such an increase in per capita consumption will occur is dependent upon several assumptions already discussed with respect to Southern California Edison's forecast. The most important of these assumptions is that the supply of natural gas will rapidly diminish within the near future resulting in a moritorium on future hookups and perhaps curtailment of existing services. The effect of this will be a rather substantial switch to complete reliance on electricity thereby increasing per capita consumption.

Although predictions concerning commercial per capita consumption are not available, it seems that the per capita consumption in this sector will not rise as quickly as in the residential sector. This inference is made on the basis of the data contained in Figure 9 which shows that the residential sector will consume an increasing share of the total kilowatt-hour sales -- moving from 39% of the total sales to 47%, while commercial sales decline from 57% in 1978 to around 50% in 1995. Considering the broad range of consumers which are placed in the commercial sector, it is significant that the residential sector is forecast to consume such a large share of the total electrical demand. From this, it seems that a great deal of residential growth is expected to take place in the SDG&E service area. It appears that the San Diego County area will be a primarily service-oriented one, with relatively little heavy industry moving into the area.

FIGURE 1 (SCE)

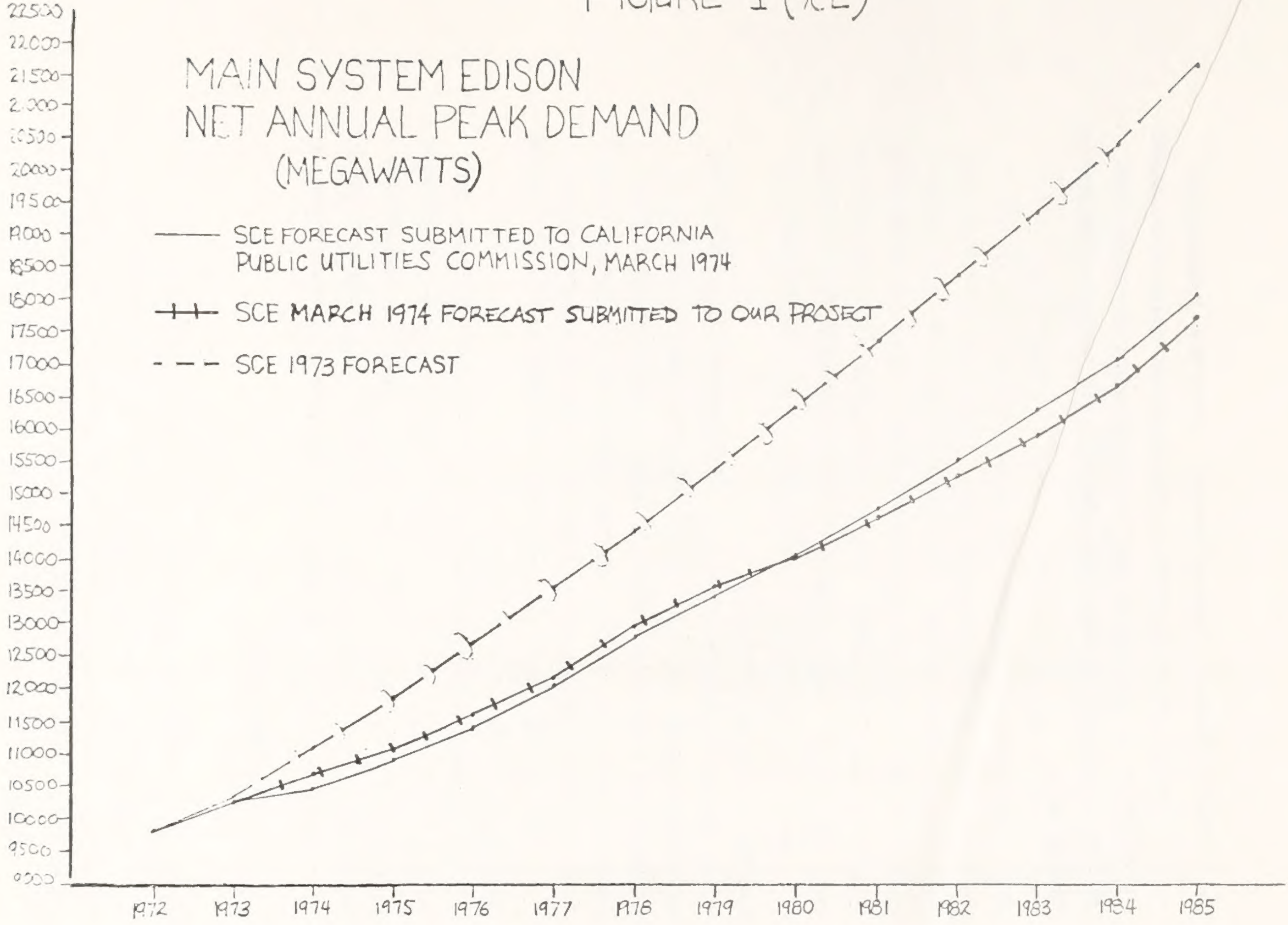


FIGURE 2 (SCE)

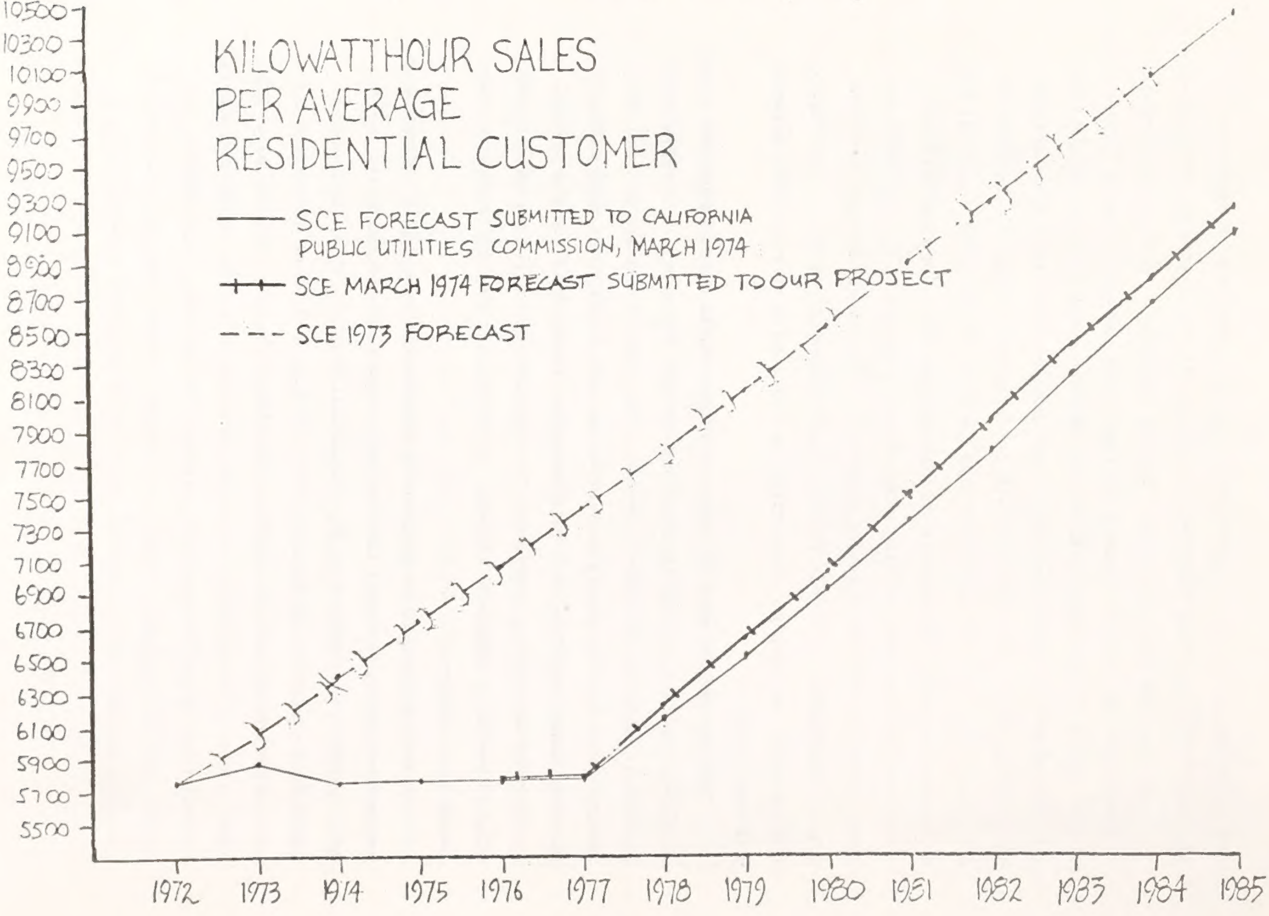


FIGURE 3 (SCE)

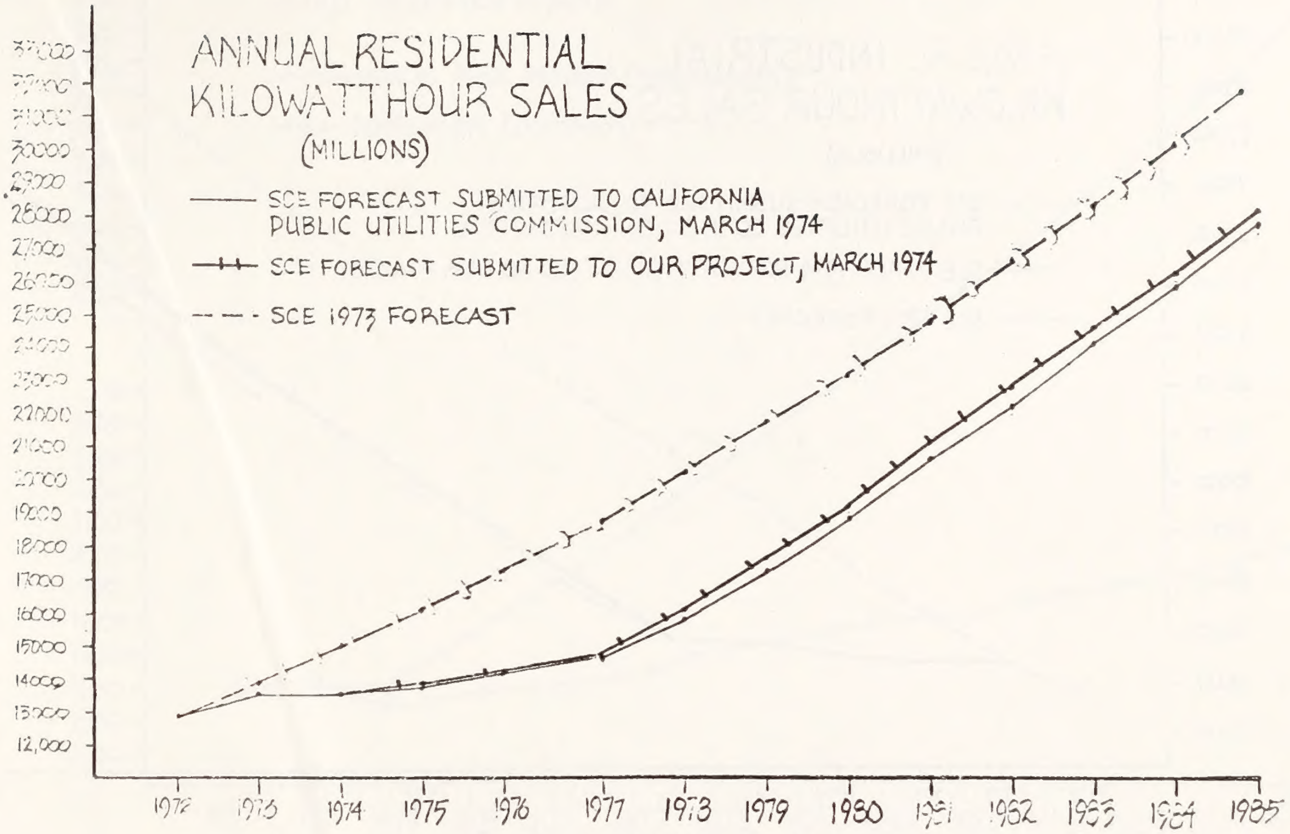


FIGURE 4 (SCE)

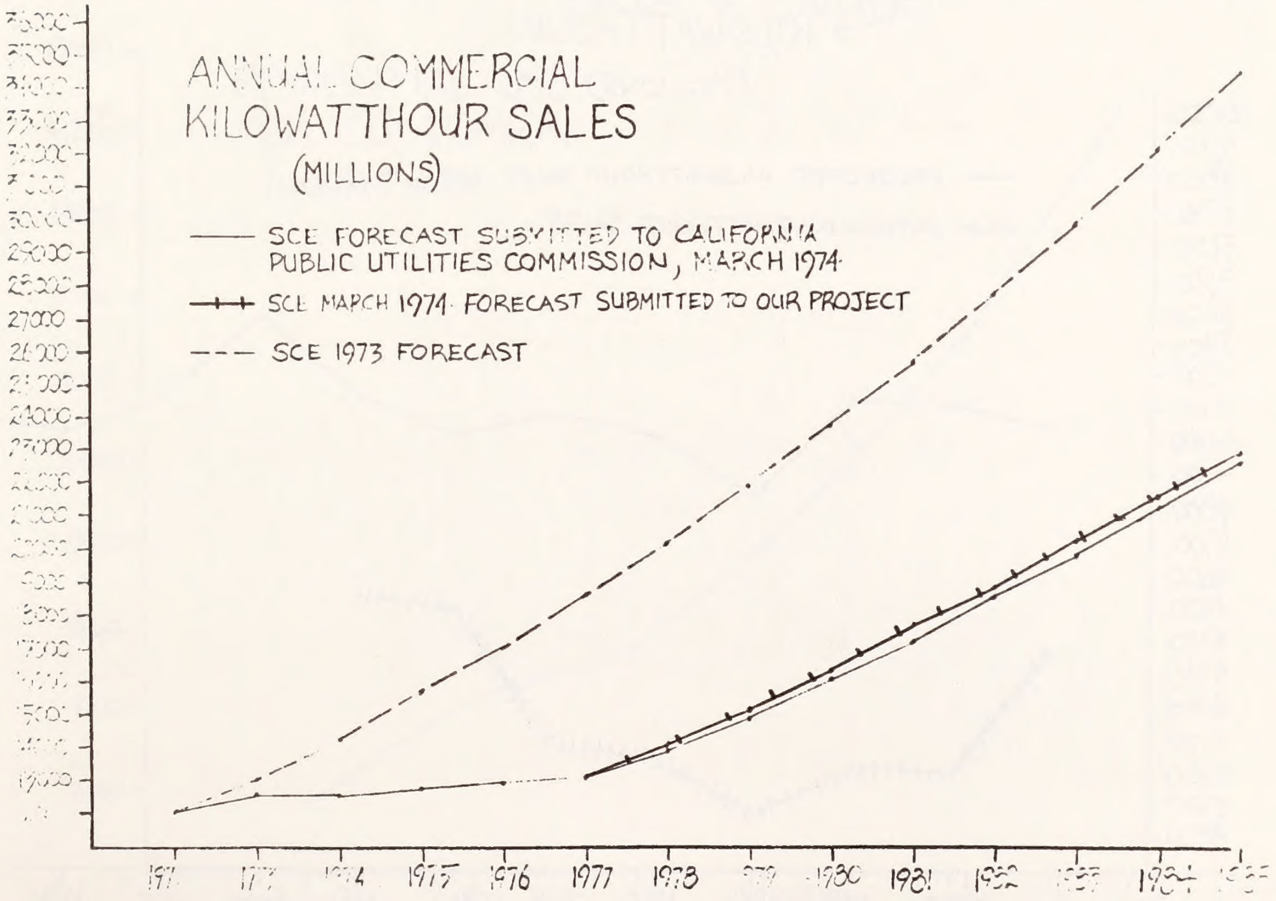


FIGURE 5 (SCE)

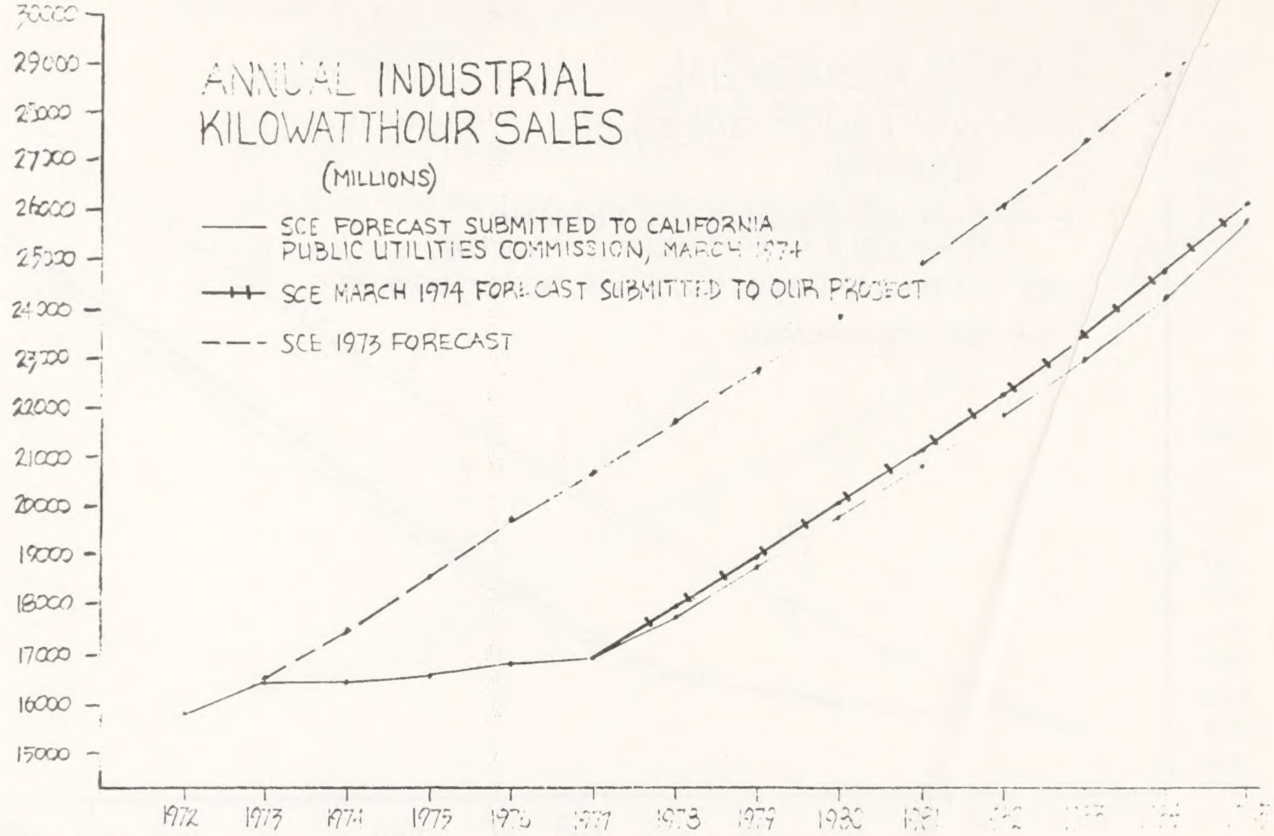


FIGURE 6 (SCE)

ACTUAL SALES COMPARED TO PROJECTED SALES FOR 1974
KILOWATTHOUR
(MILLIONS)

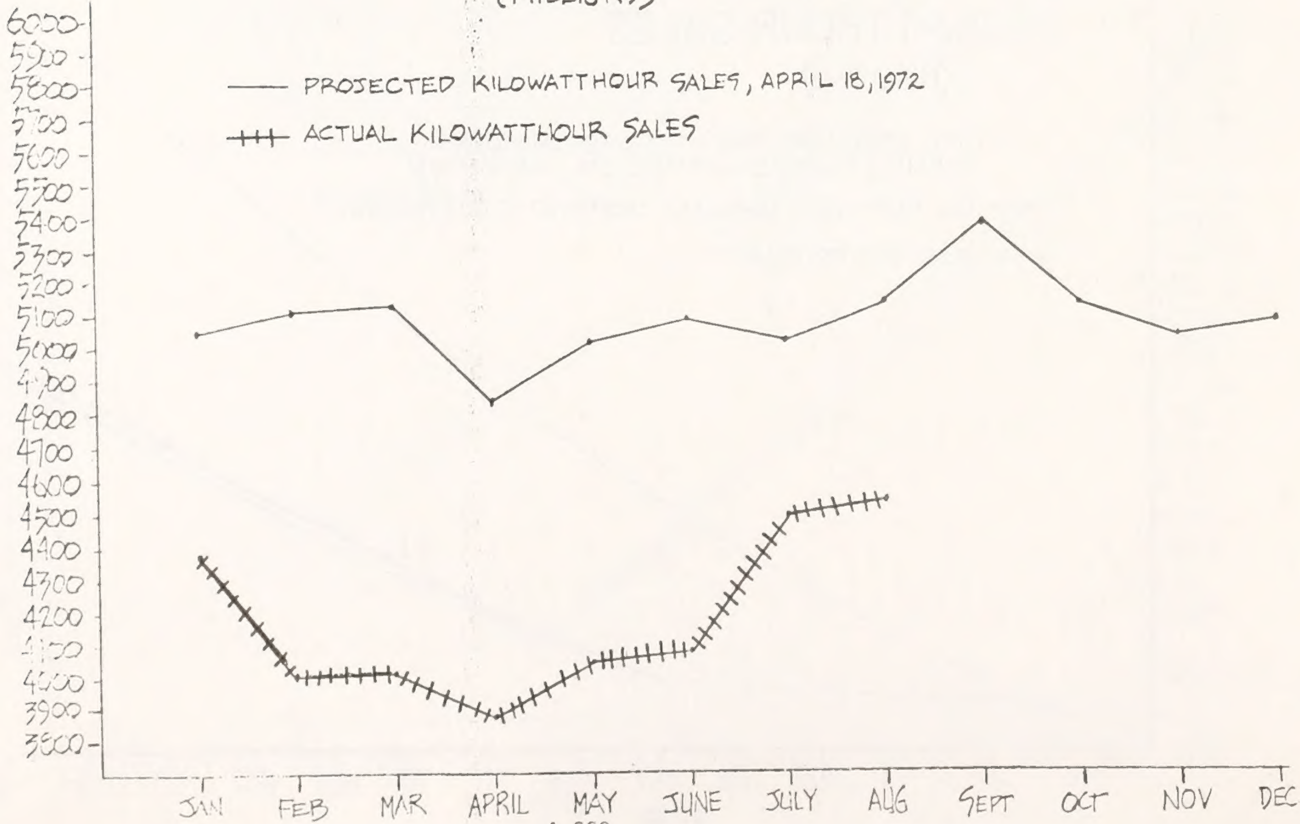
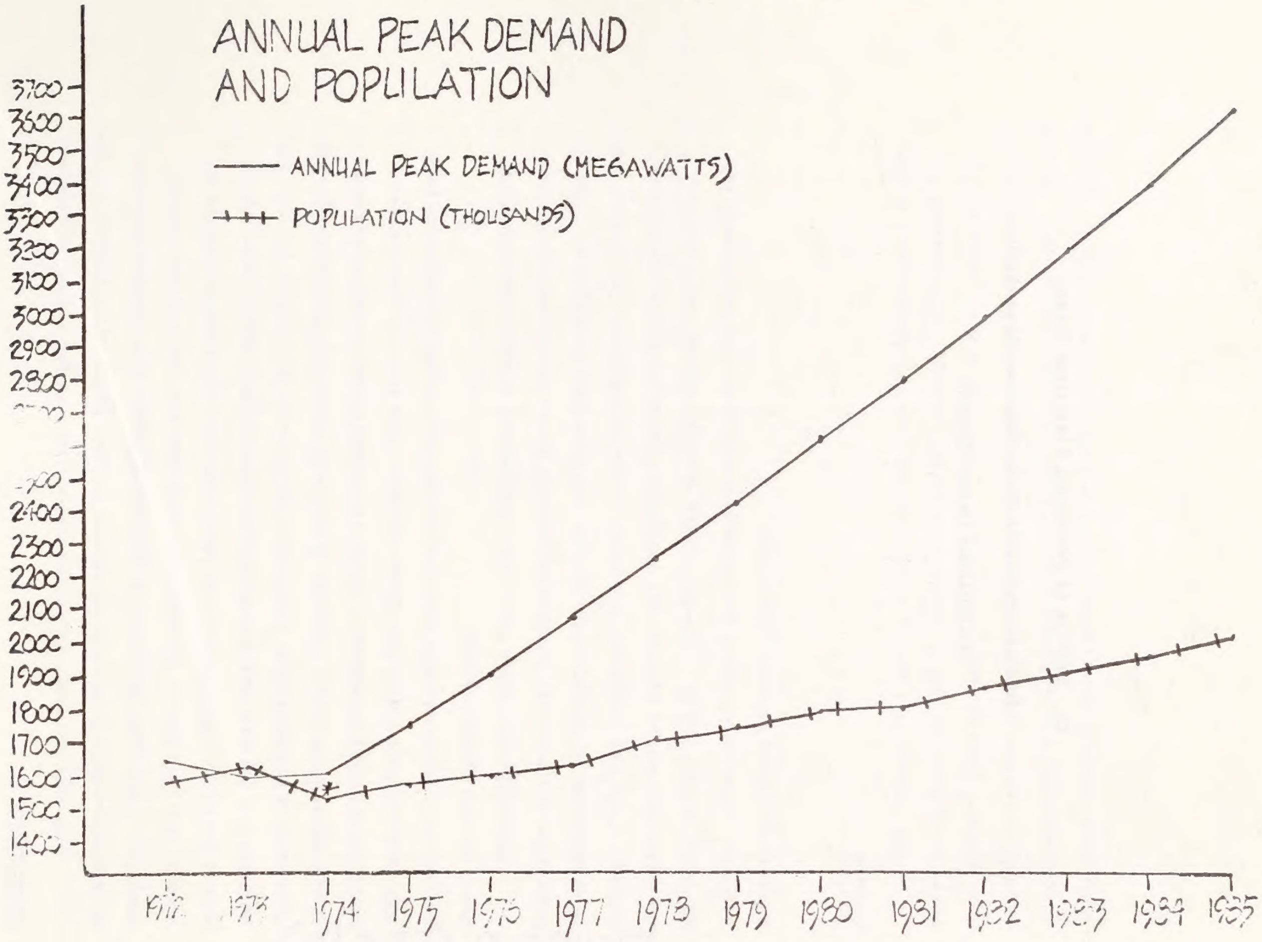
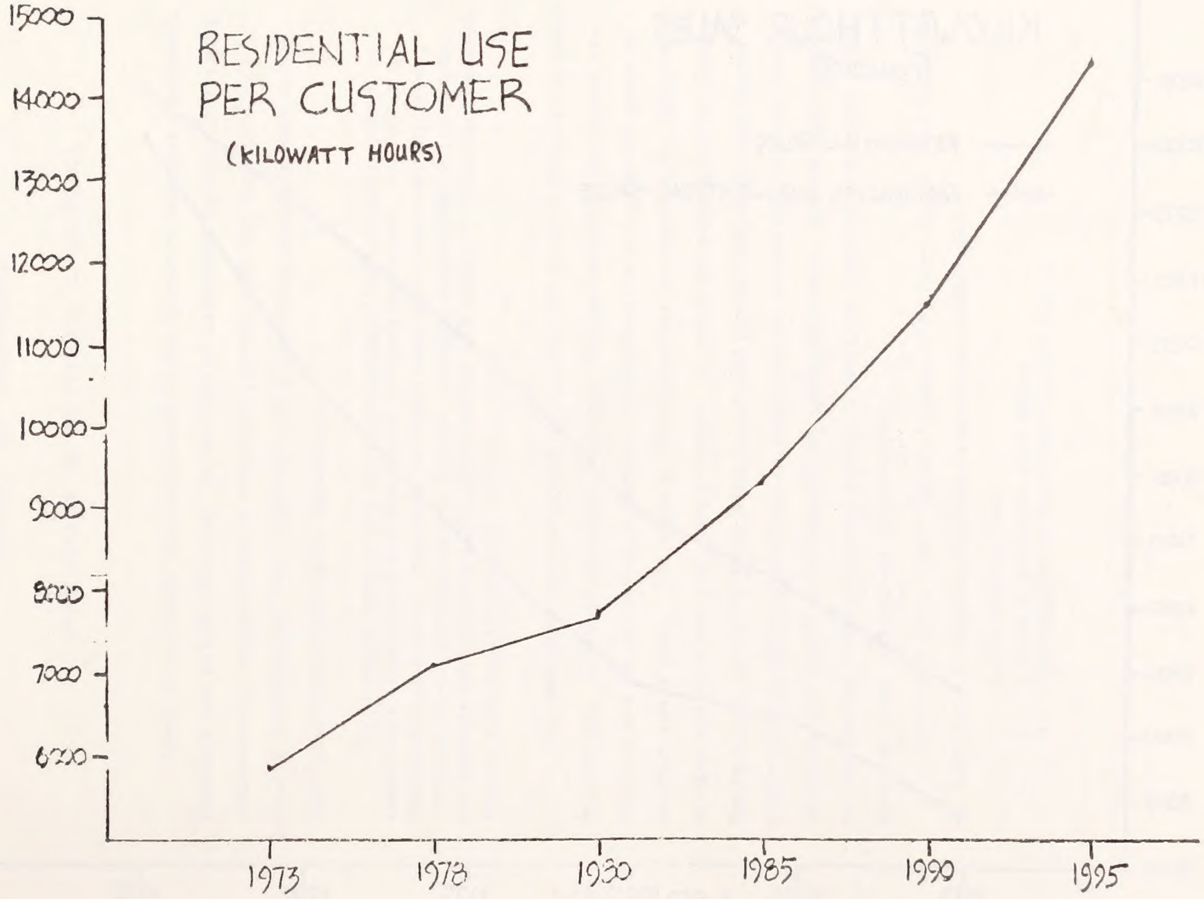


FIGURE 7 (SDG&E)



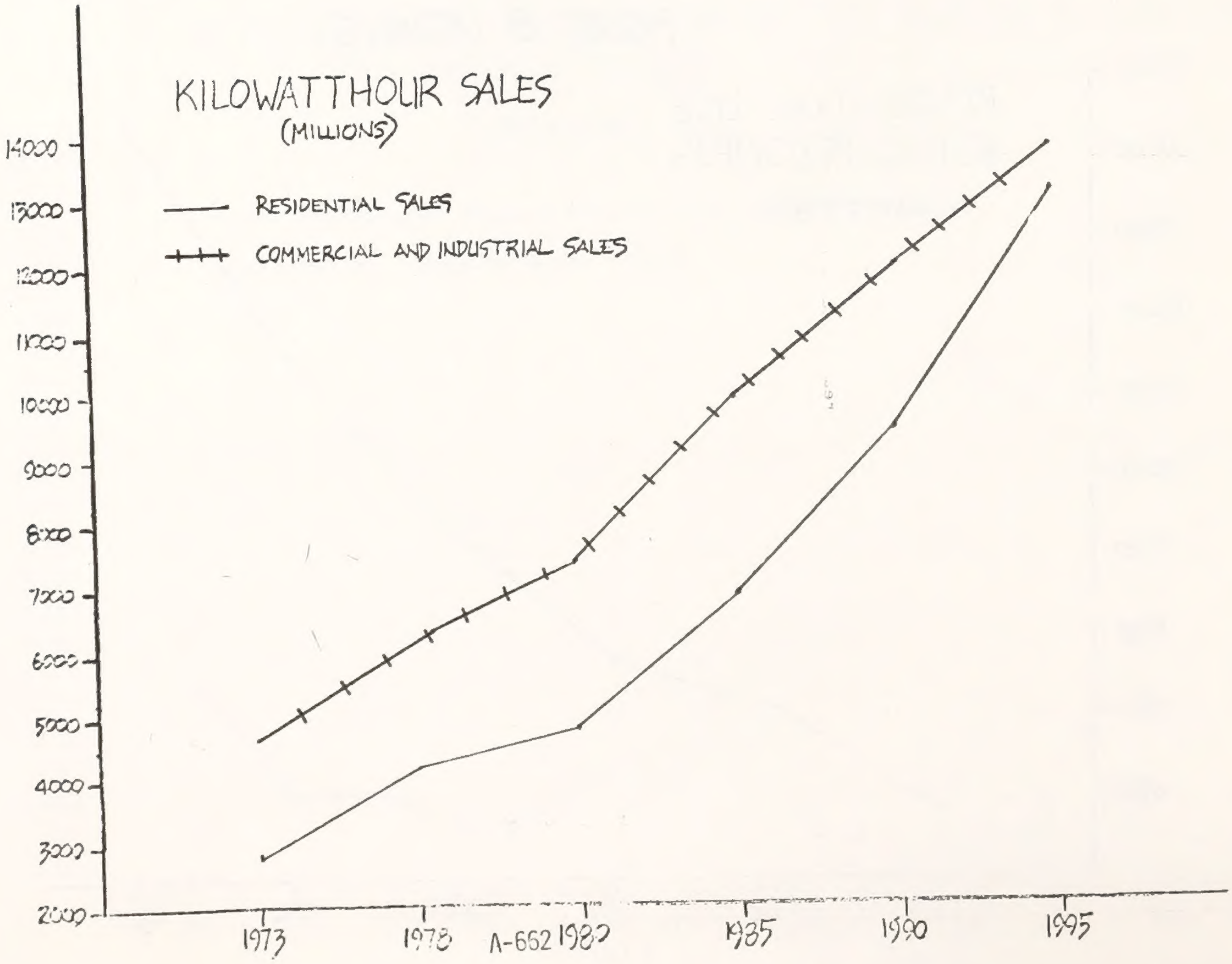
* BASED ON FORECAST 1974-1985 BASED ON 1974 FORECAST - 1972 AND 1973 FIGURES

FIGURE 8 (SDG&E)



II. Effects of Providing Electrical Power from Kaiparowits to the Service Area As It Facilitates Urban Growth

FIGURE 9 (SDG&E)



EFFECT ON CALIFORNIA

OPEN SPACE IN SOUTHERN CALIFORNIA

Open space needs are very much on the minds ot Southern California planners and public officials. In the face of estimated current open space deficiencies, the prospect of continued growth, with the resultant loss of land to development, will make the job of providing adequate open space that much harder and more expensive.

> "Open space land is any parcel or area of land or water which is essentially unimproved and devoted to an open space use, and which is designated on a local, regional, or state open space plan for the preservation of natural resources, for the managed production of resources, for outdoor recreation or for public health and safety." (Source: General Plan of Los Angeles County, 1973)

This definition points out the many different uses to which open space may be put. In urban Southern California the preservation of natural resources and the provision of outdoor recreation are the primary goals of an open space plan. The State of California has recognized the importance of open space in and near urban areas. Through the passage of the Open Space Lands Act of 1970 the state found that preservation of open space and avoidance of the premature or unnecessary conversion of open space to urban type development was in the public interest. As one expression of this finding, every city and county in the state must have an open space element in its (required) general plan.

There are three major ways of preserving open space, and they have all been used to varying degrees in Southern California:

1. Acquisition of land
2. Zoning to maintain open space
3. Inducements to keep land in open space

Acquisition

Although the most expensive route, the outright acquisition of land by a public entity is the surest avenue to open space preservation for the long run. Through the power of eminent domain, government can purchase, at a fair price, literally any land that will be used for a valid public purpose. The transfer of land from one governmental entity to another is a further way that local government has aquired open space. This kind of transfer is of particular importance in counties such as San Diego where such large amounts of land are owned by the federal government for military purposes. Camp Pendleton alone encompasses over 380 square miles within San Diego County. The federal government periodically gives or sells land not needed any longer for military purposes to local governments.

Because open space land in or near urban areas is usually very expensive to purchase, local governments have sometimes bought land in anticipation of future urban growth and have thus managed to "save" money. This has happened in several areas in Southern California where the pattern of urban sprawl was obviously leading to future open space needs in certain areas. Growth during the last decade and a half has, however, often outstripped government's ability to stay ahead with the advance purchase of open space land.

Zoning

The reason that zoning is the most common technique used to preserve open space is that it involves no public money. With respect to open space zoning is used in two ways. First, to protect public safety and health certain lands are usually zoned open space because they represent potential flood, earthquake, or slide hazards if developed. Second, some land is zoned open space simply in order to conserve land. Because zoning is traditionally a matter left to each local government, and given the large number of independent governments in Southern California, a wide array of open space policy exists. Some suburban governments plan for little open space within their boundaries because adjoining cities have facilities which are used by residents from the entire area. This creates inequities in taxation within a region. Another problem with the use of zoning as a mainstay of an open space plan is that the pressures to develop land are usually more than can be withstood by the typical city council. The entire history of Southern California sprawl has been written by the continuous granting of zoning variances and zoning changes by local governments to land developers. The conversion of agricultural land (sometimes thought of as real or potential open space) to urban developments has been commonplace throughout the area.

Inducement

The main inducement to keep land in open space in California is the policy of taxing certain privately held agricultural lands at a rate commensurate with its open space designation rather than its potential higher urban value. Through the Land Conservation Act of 1965 (known as the Williamson Act) local governments may enter into contracts (some as long as 25 years) with owners of large amounts of agricultural land. These contracts basically say that the land owner will keep the land in its open space character and in return he will be taxed at the value of open space and not the potential urban value of the land. While it does not address the need for recreational opportunities the Williamson Act has provided the opportunity for Southern California local governments to keep large amounts of land in open space. For instance, by 1972 San Diego County had established agricultural preserves, under the Williamson Act, totaling approximately 120,000 acres.

Recreation

One of the primary uses of open space is for recreational purposes. To give an illustration of the magnitude of the open space issue in Southern California and the impact that continued growth can have in this area some data from the Southern California Association of Governments (SCAG) are presented. The SCAG region consists of the counties of Los Angeles, Ventura, San Bernardino, Riverside, Orange, and Imperial. (See Map in Section I)

SCAG planning documents assume that there are 40 days of outdoor recreation use per person per year. Assuming a current population in Southern California of approximately 10 million then:

10 million X 40 visit days = 400,000,000 visit days per year

If the population of the region were to grow by 2 million in the next twenty five years then:

12 million X 40 visit days = 480,000,000 visit days per year

Therefore, an increase of 20% in population will produce a like 20% increase in recreational use but the size of the increase in recreational use is staggering -- 80,000,000 visit days per year. As this increase in recreational use is occuring, the very fact that the 2 million more people have moved into the region means that there will be less land available to develop as recreational open space. And to show a further problem, these data must be understood in light of the assumption made above that throughout the rest of this century the per capita recreational use will remain constant. Yet the amount of leisure time available to Americans is steadily increasing as the average work-week is reduced in hours. If one assumes an increase in the per capita yearly use of recreational facilities then even the large increase in demand just forecast will be less than reality.

There are advantages and disadvantages to a policy of open space preservation. In Southern California it has been argued that some of the advantages include:

1. Provision of recreational opportunities
2. Provision of pockets of clean air
3. Provision of barriers against noise
4. Improves sense of openness and calm that is often missing from urban life
5. Helps shape the form of urban growth and can be used to prevent costly urban sprawl

From another point of view, an open space policy has been said to have two major disadvantages:

1. Removes land from tax rolls or if Williamson Act is applied it reduces tax revenues.
2. Prevents developers from developing certain lands with resulting possible impact on the local economy, especially the construction industry.

However, the "debate" over open space policy in Southern California is about the amount and location of open space not about the advisability of having open space. This is essentially a political battle where the advice of professional planners is ignored as often as it is followed.

The main point is clear: As population grows there will be an increased demand for open space facilities. There is a good deal of planning activity for open space capital improvement in both the SCAG area and San Diego. (Capital improvement refers to purchase, construction or acquisition on a non-recurring basis of a facility to be used as part of an open space plan.) For instance, in the five years between 1972 and 1977 within the SCAG region, there are 147 cities, 49 special districts, and 6 counties involved in open space planning for over 840 projects. Although it is unlikely that all of these projects will be funded and actually implemented, the sheer magnitude of the effort reveals the intensity with which those in local government in Southern California address the open space issue. As growth continues in the impact area the procurement of adequate open space will be one of the most difficult and controversial issues for local government.

Standards for Open Space

Several attempts have been made to develop criteria or standards by which local communities could judge the adequacy of that part of their open space which is intended for parks and recreation. There is no universally accepted standard, but the following table shows the range of suggested standards for the acres per 1000 people that should be in open space for parks and recreation.

Agency Suggesting Standard	Local Open Space	Regional Open Space
Association of Bay Area Governments (San Francisco)	15	15
National Parks and Recreation Association	20	40
U.S. Bureau of Outdoor Recreation	5	12
Arizona Outdoor Recreation Coordinating Commission	7	18

San Diego County is using as a planning standard the criteria of 15 acres of local open space and 15 acres of regional open space per 1000 people. Los Angeles County has adopted a much more modest criteria: 4 acres for local open space and 6 acres for regional open space per 1000 people. Local open space consists of such things as neighborhood parks, pocket parks, school playgrounds, and neighborhood trails. Regional open space refers to such facilities as lakes, beaches, mountain recreational areas and other such facilities designed to attract people from a radius of one hour's driving time.

Table 6

1972 Recreation Resource Areas Inventory (in Acres)*

County	Urban Local	Urban Regional	Coastline	Types of Area Desert	Inland Water	Mountains
Imperial	178.2	494.1	0	State 34,609 Fed. 637,079	288,520	0
Los Angeles	4,490.1	17,927.9	1,569	Co. 1,547 State 2,875 Fed. 2,500	14,165	Co. 1,310 State 2,053 Fed. 649,045
Orange	2,310.2	2,423.0	953	Fed. 1	1,002	Fed. 51,813
Riverside	1,234.5	5,173.3	0	Co. 21,225 Fed. 2,225,125	61,778	Co. 349 State 1,351 Fed. 258,284
San Bernardino	1,344.5	5,930.0	0	Co. 630 Fed. 6,977,628	9,413	Co. 102 State 9,415 Fed. 427,035
Ventura	647.3	3,700.7	654	Fed. 1,000	8,878	State 6,554 Fed. 2,085
Total Region	10,204.8	35,649.0	3,176	approx.9,904,219	383,756	1,409,396

*Source: Southern California Association of Governments

Recreational Acreage in the SCAG Region

Table 6 shows the amount of acreage in the six county SCAG region which is in recreational usage. San Diego is not included in the table. One of the conclusions to be derived from examing this table is that local recreational land in urban areas is in substantially less supply than might be called for in the criteria presented above. The table also shows the very large amount of land that is available for recreational use in the regional, coastline, desert, inland water and mountain categories. The vast majority of residents in Southern California must commute considerable distance to enjoy these recreational opportunities. An outdoor oriented recreational life style, coupled with a heavy dependence upon the automobile, means that residents drive very frequently to recreational areas. This in turn contributes to problems of air pollution. Given present trends, increased growth will mean more usage of recreational areas, which in turn will mean more automobile trips.

TABLE 7 - SELECTED OUTDOOR RECREATION FACILITIES - 1972

County of Los Angeles

Facility	Primary Responsibility	Size	Existing Number	Total Acreage	County Standards	Present Requirements	Present Deficiency	1990 Requirements[a]	Deficiency to 1990
Local Parks & Recreation Centers	Cities County	1-49 acres	655	7,096	1-1/2 acres/ 1000 persons	10,549 acres	3,453 acres (33%)	11,550 acres	4,454 acres
School Playgrounds[b]	School Districts	Varies	1,454	8,802	2-1/2 acres/ 1000 persons	17,580 acres	8,778 acres (49%)	19,250 acres	10,448 acres
Regional Parks and Botanical Gardens	County Cities	50 acres & over	86	41,171	6 acres/ 1000 persons	42,192 acres	1,021 acres (02.5%)	46,200 acres	5,029 acres
	SUBTOTAL			57,069	10 acres/ 1000 persons	70,321 acres	13,252 acres (19%)	77,000 acres	19,931 acres
Golf Courses	County and Private (if open to Public)	120-160 acres for an 18-hole par 72 course	75 including 16 within regional parks	9,141[c]	One standard 18-hole course for each 90,000 persons	77 18-hole courses	[d] 2 18-hole courses	85 18-hole courses	10 18-hole courses
Beaches	State County, Coastal Cities	Varies	20	1,372	All Available Beach Frontage		Not Applicable		
	GRAND TOTAL:			67,582					

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a - Assuming a population increase to 7.7 million and no change in county standards.
b - Elementary through high school with existing play area, based on State of California standards.
c - Acreage of golf courses outside of regional parks.
d - There are sixteen 18 hole golf courses in Regional Parks and 59 outside Regional Parks.

Open Space in Los Angeles County

Los Angeles County has the largest population in the impact area, and it still contains large potential for growth. Several major conclusions can be drawn from the official plans for open space in Los Angeles County.

The County has found that there currently exists a deficiency of 3450 acres of local parks within the urban areas of the county. Further growth will clearly exacerbate this deficiency. Primarily because of the large number of separate governmental jurisdictions within the county, there is neither a unified policy on open space nor is there any single agency responsible for open space acquisition and management. The absence of a unified approach to the subject leads to duplication of some efforts within the same county and it also creats inequities where some communities rely upon neighboring communities to provide open space opportunities. The County has developed (and SCAG had for the entire six county region) a priority list of areas that should become parks or other recreational areas. Some progress toward implementation of this priority list has been made but there is no question that all currently identified needs will not be fulfilled in the near term future.

Table 7 presents a good summary of the amount and type of currently available outdoor recreational facilities in Los Angeles County as well as a projected 1990 deficiency. These figures are based on what appear to be realistic population growth estimates. The need to acquire an additional 19,931 acres of land within Los Angeles County for outdoor recreation will be very expensive and potentially controversial. Approximately 73% of the projected 1990 deficiency is in local parks (identified in the table as local parks and recreation centers plus school playgrounds). While this local park deficiency currently exists and will continue to exist throughout the county, the most acute need is in the older urban areas, primarily within the City of Los Angeles. These areas tend to be populated by racial and ethnic minority groups which have not always been successful in securing an equitable distribution of public services. The potential exists for a serious controversy over open space policy as the county continues to grow outward. This controversy would take place between those residents living in park-poor older areas and those residents living in the newer parts of the sprawl.

Open Space in San Diego County

For further illustrative purposes an examination of some major features of open policy and problems in San Diego County is presented.

Over one-half of the land area in the county (2685 square miles) is in public ownership and most of this is essentially undeveloped. However, most of this land in public ownership is either held by the federal government for military purposes or it is in the mountain and desert area far removed from the urban population, which is located in the western coastal section of the county. There is a need for more open space near or at least easily accessible to the urban population centers. In a similar vein, and with respect to park acreage, San Diego probably does not have a deficiency of park land. However, because this park land is not evenly distributed throughout the urbanized or soon to be urbanized areas, more open space for park land is needed if all citizens are to have access to open space. Table 8 highlights the deficiencies in local recreational open space and at the same time points out the abundance of regional open space.

Some of the most thorough planning for open space in San Diego County has been completed by the San Diego Comprehensive Planning Organization, a group comprised of most cities in the county and the County. The Comprehensive Planning Organization calls for the preservation of 3637 square miles of the county's total 4255 square miles in open space. Almost 75% of this 3637 square miles is already in public ownership, although as has been pointed out most of it is not accessible to the urbanized sector of the population.

Five categories of open space have been proposed in San Diego by the Comprehensive Planning Organization:

1. Existing predominantly open space land in public ownership (2685 square miles)
2. Core open space (732 square miles including water areas) This is land which warrants preservation as open space simply because of the intrinsic qualities of the land.
3. Open Space to shape urban form (157 square miles) This is necessary if the coastal (highly urbanized) sector is not to become an endless sprawl.
4. Transportation corridors (46 square miles) These are bands of open space along or adjacent to freeways and major streets. These corridors will both link core open space areas and also help shape urban growth.
5. Recreation/scenic corridors (17 square miles) These will be located along streambeds, ridgelines, and within canyons and similar areas.

Table 8

San Diego County Local Recreational Open Space Lands

Deficiency For Each City and The Unincorporated Area

	Existing (Acres)	Deficiency 1970 (Acres)	Deficiency 1980 (Acres)	Deficiency 1990 (Acres)
Carlsbad	15.9	-208	-269	-404
Chula Vista	119.0	-900	-1,069	-1,351
Coronado	22.6	-291	-307	-322
Del Mar	-	-60	-75	-105
El Cajon	34.0	-751	-896	-1,075
Escondido	127.4	-425	-593	-773
Imperial Beach	7.7	-295	-337	-412
La Mesa	63.5	-524	-641	-806
National City	114.5	-533	-545	-575
Oceanside	180.6	-427	-629	-824
San Diego	1,546.5	-8,905	-9,583	-10,888
San Marcos	33.0	-26	-42	-72
Vista	47.4	-324	-433	-553
Unincorporated	402.0	-3,987	-4,938	-6,873
County Total	2,714.1	-17,686	-20,386	-25,036

San Diego County Regional Recreational Open Space Lands

Surplus or Deficiency by Major Statistical Area

	Existing (Acres)	Surplus or Deficiency 1970 (Acres)	Surplus or Deficiency 1980 (Acres)	Surplus or Deficiency 1990 (Acres)
Central	1,863	-5,472	-5,832	-6,252
North City	9,133	+4,873	+3,868	+2,143
South Suburban	4,005	+2,055	+1,815	+1,350
East Suburban	5,272	+2,017	+1,657	+1,147
North County	6,562	+3,082	+2,347	+862
East County	1,009,072	+1,008,952	+1,008,922	+1,008,877
County Total	1,035,907	+1,015,507	+1,012,807	+1,008,157

(Source: San Diego Comprehensive Planning Organization, 1973)

POLLUTION

Urban growth is at the heart of Southern California's environmental problems. The desirable natural characteristics of Southern California which have attracted people to the area have been jeopardized by excessive urban growth. The mild and sunny climate has been threatened by a hazy smog which irritates the eyes and lungs; the mountains have been encased in a sheath of smog, and as people have overflowed the coastal lowlands, the mountains have been subjected to excessive development; the ocean and beaches have been the unwilling victims of oil spills; and the delicate ecological balance of the deserts has been threatened by surges of urban dwellers seeking weekend recreation.

Large-scale urban growth puts pressure on both the natural and man-made physical environments. If this pressure is too great, it results in the deterioration of environmental quality. Largely unplanned and unchecked urban growth has put too much pressure on Southern California's environment, resulting in congestion and in esthetic pollution, noise pollution, water pollution, and air pollution. Many miles of Southern California streets traverse through a maze of hamburger stands, gas stations, neon signs, and billboards.

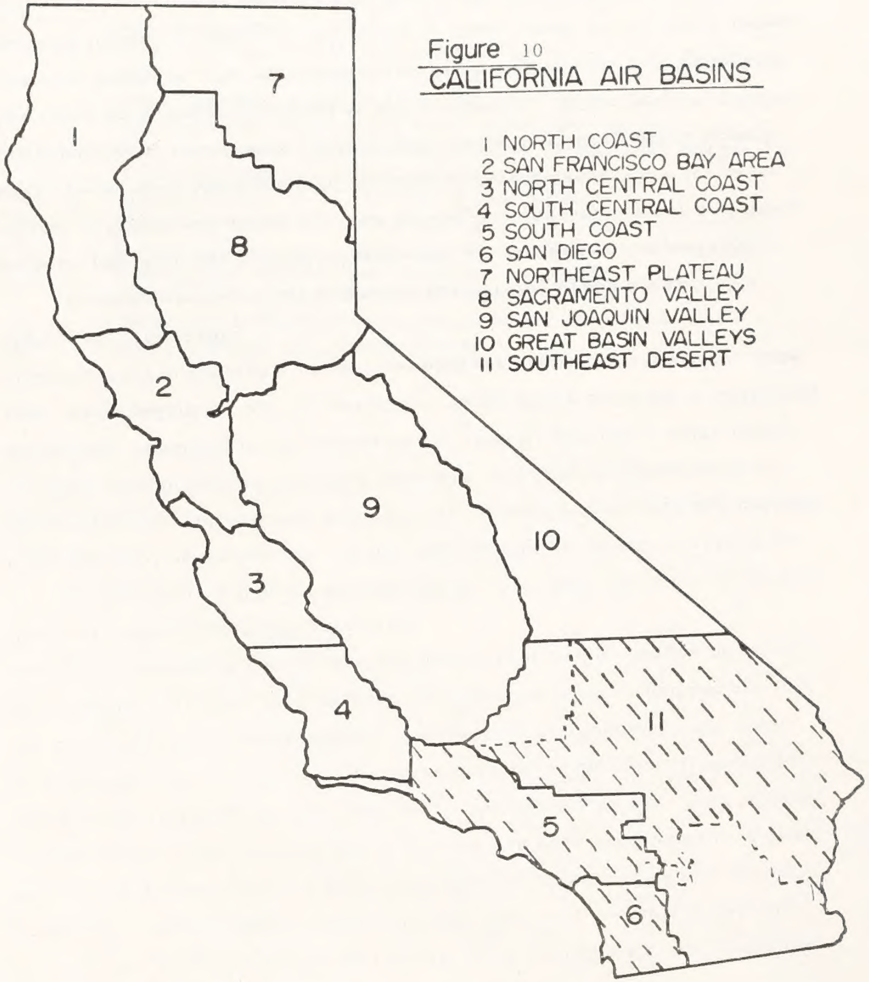
Because excessive urban growth has become urban sprawl, this esthetic pollution has spread amoeba-like and has become especially typical of Southern California. The sprawl has consumed more and more open space, destroying much of the natural environment which formerly provided visual relief from urban blight. With increasing urban growth has come an increasing amount of noise pollution. Motor vehicle exhaust systems and tires, the operation of industrial equipment, and inadequate building insulation have all contributed to noise levels which cause human stress and sometimes even hearing loss. But the most burdensome form of noise pollution has been due to air transportation. Despite some technological advances in noise abatement in the newer aircraft, as urban growth generates more demand for air transportation, the noise level around an airport is multiplied. For example, the number of people in San Diego County subjected to excessive noise levels around airports is expected to increase by almost 80,000 by the year 1995, despite the advent of new, quieter airplanes.

Also with increasing urban growth has come an increase in water pollution. Southern California has escaped some of the water pollution experienced by the rest of the country merely because it does not have as many rivers to use as sewers for industrial and residential wastes. Wastewater, after some treatment, is dumped into the Pacific Ocean. Water pollution in the ocean comes from oil spills and discharges from ships and off-shore drilling platforms. Plans are being made for expanded drilling programs to obtain more oil and with the expansion comes the risk of more oil spills.

But more obvious even than esthetic pollution, noise pollution, and water pollution in Southern California is air pollution. The single greatest source of air pollution is the automobile. The automobile is responsible for more than seventy percent of the smog in the South Coast Air Basin and for as much as eighty-eight percent of the total tons of emissions per day in the basin. (See Figure 10 for an indication of the air basins which cover the Southern California Edison and San Diego Gas and Electric service areas.) Indeed, in Los Angeles county alone motor vehicles emit 12,000 tons of pollutants into the air every day. This amount will increase as the number of vehicles in the area increases. In 1970 there were thirteen million gas-powered vehicles in the state, approximately half of which were registered in the South Coast Air Basin. By 1980 there are expected to be more than sixteen million gas-powered vehicles in the state.

California has not been able to cope with the air pollution produced by the vehicles currently in the state. In 1970, twenty-five years after

Figure 10
CALIFORNIA AIR BASINS



Dashes indicate impact area.

Source: Environmental Quality Laboratory Report No. 3. (1971)

California enacted its first air pollution control law, Los Angeles County still was unable to meet the standards for photochemical oxidants on sixty-five percent of the days, for carbon monoxide on fifty-five percent of the days, and for nitrogen dioxide on thirty-one percent of the days. All of these pollutants can be traced to the automobile. Photochemical oxidant, or photochemical smog, is derived from photochemical reactions in the atmosphere of nonmethane hydrocarbons, nitrogen oxides, and oxygenated organic compounds in the presence of sunlight and oxygen. Nonmethane hydrocarbons and nitrogen oxides are the primary contaminants. Hydrocarbons come mainly from unburned gasoline vapors emitted by the automobile, while nitrogen oxides come mainly from the combustion of gasoline in automobile engines and to a slightly lesser extent from the combustion of fossil fuels in the electric power plants. Nitrogen dioxide is the brownish-yellow gas largely responsible for the color of the air over regions subjected to photochemical smog. Carbon monoxide, produced from incomplete combustion of carbonaceous substances, also comes primarily from the automobile.

Air pollution is commonly measured in two ways. First, it is measured in terms of the maximum concentration of various pollutants when the concentration of these pollutants is in excess of the National Primary Air Quality Standards. Table 9 shows the five worst pollutants in the Los Angeles Air Quality Control Region and the maximum amounts in which they were concentrated in 1970. Clearly, photochemical oxidant is the pollutant found in the most excessive concentrations. Second, air pollution is measured in terms of the frequency with which various pollutants are found in concentrations in excess of the national standards. The map accompanying Table 9 shows the number of days that the National Air Quality Standard was violated at each of the monitoring stations in the Los Angeles Air Quality Control Region. As might be expected, the coastline areas experienced fewer days of exposure to

Table 9

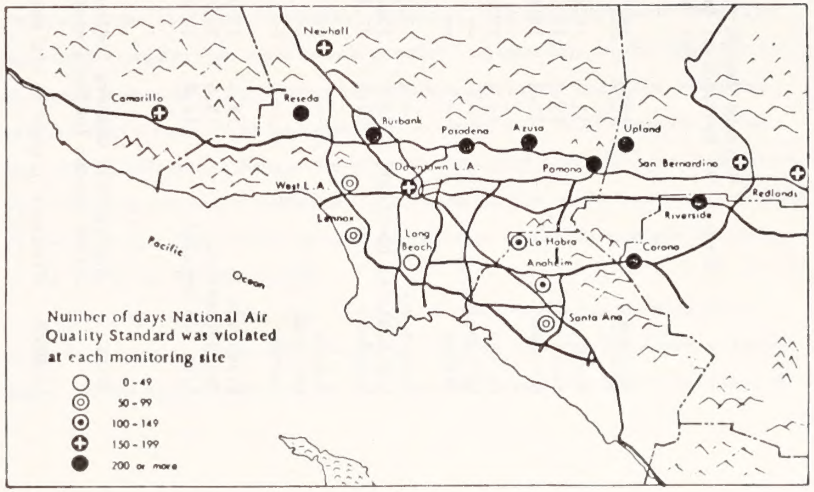
AN OVERVIEW OF AIR POLLUTION IN THE LOS ANGELES AIR QUALITY CONTROL REGION

POLLUTANT	NATIONAL AIR QUALITY STANDARD*		MAXIMUM OBSERVED IN 1970	
	Concentration	Averaging Time	Concentration	% of Standard
Photochemical Oxidant**	0.08 ppm	1 hour	0.62 ppm	780%
Carbon Monoxide	9 ppm 35 ppm	8 hours 1 hour	41 ppm 54 ppm	460% 150%
Nitrogen Dioxide	0.05 ppm	annual average	0.09 ppm	180%
Sulfur Dioxide	0.03 ppm 0.14 ppm	annual average 24 hours	0.03 ppm 0.09 ppm	100% 64%
Particulate Matter	75 $\mu g/m^3$ 260 $\mu g/m^3$	AGM 24 hours	100 $\mu g/m^3$ 399 $\mu g/m^3$	130% 150%

* National primary standard shown for each pollutant. The primary standard is intended to protect the public health; secondary standards are long-range goals intended "to protect the public welfare" (e.g., prevent damage to vegetation). For photochemical oxidant, these standards are identical.

** Photochemical oxidant here denotes a complex mixture of oxidizing substances that are physiologically harmfull to humans and plants and are aesthetically objectionable. The National Air Quality Standard for oxidant was set by EPA and is designed to protect all segments of the population from any of the adverse health effects associated with oxidant pollution of the air.

Spatial distribution of air pollution in the Los Angeles Air Quality Control Region for 1970



Source: Rand Corporation Report R-1524-SCAG. June, 1974.

excessive concentrations of air pollutants than did the areas along the base of the San Gabriel Mountains and in the more heavily populated inland valleys.

Though smog is still a very dominant presence in Southern California, it is not as prevalent as it once was. The concentration of photochemical oxidant in Los Angeles County peaked in 1966 and has been declining since. Table 10 shows the oxidant trends in the South Coast Air Basin from 1963 to 1972. The concentration of oxidant at each of the monitoring sites is circled to indicate the year at which the oxidant level peaked at that site.

Projections of future levels of air pollution in Southern California are in dispute. The current downward trend in the levels of air pollution brought about by automobile emission controls can be expected to continue at least for the remainder of this decade as an increasingly higher percentage of automobiles are equipped with emission control devices. State officials had even predicted that present emission control programs will allow California to enjoy "clean" air (i.e., air which meets existing state air quality standards) by 1990. However, other experts have predicted that the air will start to deteriorate again by 1982 because of the growth in the number of new sources of emissions. This prediction assumes that additional vehicles, additional plants, and additional pollution-making affluence will offset improvements in emission control devices. A somewhat different projection comes from a third group of experts who predict a continued decrease in the level of air pollution through 1990 but not that Californians will be able to enjoy clean air by 1990. By the late 1980s, these experts say, when the benefit of stringent federal emission standards will be substantially realized, the oxidant standard will be violated on as many as 135 days per year at the worst point in the region. Indeed, some argue that the National Air Quality Standard for oxidant may never be achieved in the Los Angeles

TABLE 10

Oxidant Trends in the South Coast Air Basin, 1963-1972
Three-Month Averages of Daily Maximum One-Hour Oxidant Concentrations
For July, August & September
(pphm)

Station	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Anaheim	11.4	9.6	15.9	14.1	12.5	11.9	13.7	10.7	8.9	8.7
Azusa	19.8	24.2	24.4	25.8	26.8	21.9	28.0	28.8	22.9	18.1
Burbank	15.1	15.6	20.9	17.0	22.5	19.0	19.4	18.5	16.1	13.2
Corona	16.4	25.6	16.7	13.8	22.1	16.2	22.0	20.8	13.4	--
La Habra	--	--	15.6	13.3	9.8[a]	11.0	17.2	10.0	15.2	13.3
Lennox	--	--	7.0	7.0	6.7	6.9	6.8	6.2	5.7	3.4
Long Beach	4.2	7.3	6.8	7.8	5.9	4.6	6.3	6.0	6.2	4.0
Los Angeles, Downtown	16.2	15.7	16.2	17.3	13.9	14.3	13.0	13.2	10.0	11.4
Pasadena	20.0	21.9	21.6	22.2	22.6	22.3	27.4	25.7	20.6	17.1
Pomona	--	--	20.8	21.4	23.9	20.8	24.5	23.5	16.6	14.6
Redlands	--	--	--	--	--	17.2	20.4	20.1	17.1	13.8
Reseda	--	--	18.6	19.6	20.9	18.0	20.1	17.4	14.2	12.1
Riverside	17.4	21.2	16.6	18.6	25.2	19.5	25.6	25.6	22.9	22.2
San Bernardino	15.5	12.2	17.0	17.0	18.2	15.2	18.9	23.1	18.7	14.8
West Los Angeles	11.9	10.3	11.3	11.6	11.1	11.2	11.0	10.1	8.4	7.1

NOTE: Superscript numbers indicate number of months of missing data.
Blank spaces indicate stations were not operating.

SCOURCE: "Oxidant Trends in the South Coast Air Basin, 1963-1972," California Air Resources Board.

Air Quality Control Region, even with major reductions in the number of vehicle miles travelled, because of emissions from additional automobiles, trucks, aircraft, and stationary sources.

Out of these different predictions emerges one clear point: the South Coast Air Basin will be subjected to continuing smog. The greater the amount of growth, and the more it takes the form of automobile dependent sprawl, the worse the air pollution.

TRANSPORTATION

The history of transportation in the impact area has been the history of the automobile. Motor vehicles have served as the primary means for moving people and goods throughout this region. The primacy of the motor vehicle is well illustrated by the following table:

Motor Vehicle Registration

County	1961	1973	Percent Increase
Los Angeles	3,404,147	4,918,510	45
Orange	419,552	1,220,697	191
Ventura	112,447	300,132	167
Riverside	180,977	401,864	122
San Bernardino	281,529	522,777	86
San Diego	520,983	1,604,461	208
Total	4,919,635	8,968,441	82

The number of motor vehicles in the six county impact area has almost doubled in the last twelve years. However, the motor vehicle increase for some counties has been much greater. According to the Department of Motor Vehicles a somewhat more subdued rate of increase in motor vehicle registration can be expected -- around 4.5% per annum -- but one which will nevertheless be greater than that predicted for population. The reliance on motor vehicles for transportation is further substantiated by the fact that 73% of all registered vehicles in California are located in the six county impact area.

To accomodate the vast number of motor vehicles making daily trips in the area, California has developed an extensive system of freeways, roads and streets. There is now well over one thousand miles of freeways located within the impact area. Future freeway construction is expected to at least double, perhaps triple, this number. The following table shows the extent of freeway construction in the impact area:

Existing and Planned Freeway Construction
(Miles)

County	Freeways and Expressways in Operation	Total Planned System	Percent Increase
Los Angeles	414.5	1,042.1	151
Orange	127.7	247.6	94
Ventura	77.3	253.9	228
Riverside	188.2	392.0	108
San Bernardino	386.8	971.0	151
San Diego	195.0	300.0	54
Total	1,371.5	3,206.6	134

Motor vehicles are expected to continue to provide the major mode of transportation in the impact area.

But reliance on motor vehicles to provide for the transportation needs of Southern Californians has meant severe hardships for many segments of society, particularly the poor, handicapped and elderly who, for various reasons, do not have access to an automobile. For them, the vast freeway system and the vast number of automobiles which travel on it have not enhanced their lives. Instead, they must rely on public buses to move from place to place. Yet it has only been within the last 15-20 years that any concerted effort has been made to upgrade public transportation. The history of public transportation in Los Angeles provides a good illustration. Origionally public transportation was provided by private companies, the Pacific Electric Railway and the Los Angeles Railway Company. Increasing competition by motor coach operators eventually led to a decline in rail services. It was not until 1951 that the California legislature created the Los Angeles Metropolitan Transit Authority (later changed to the Southern California Rapid Transit District (SCRTD)), and it was not until 1957 that the MTA was empowered to acquire and consolidate privately owned systems and construct a rapid transit system. To date, buses have been the sole ingredient of the rapid transit system because voters have so far failed to approve any revenue plan for an expanded system. SCRTD plans to submit a new revenue plan for rapid transit to the voters on the November 1974 ballot. If approved SCRTD will implement its mass transit plan. Passage of the bond issue is highly problematical.

Transportation in the SCE Impact Area

A. Mass Transit

SCRTD has developed an extensive plan for public mass transit in the greater Los Angeles area. According to the SCRTD proposal, mass transit will take two forms: a near-term expansion of existing transit services and a longer range construction of a fixed guideway system similar to that already in service in the San Francisco Bay Area. The major components of the near term expansion plan are:

1. increasing the number of vehicles from 1700 to 2700 by 1977.
2. construction of park and ride facilities.
3. new express-on-freeway services to serve park and ride passengers.
4. development of new bus only lanes on freeways.
5. introduction of limited commuter rail service.

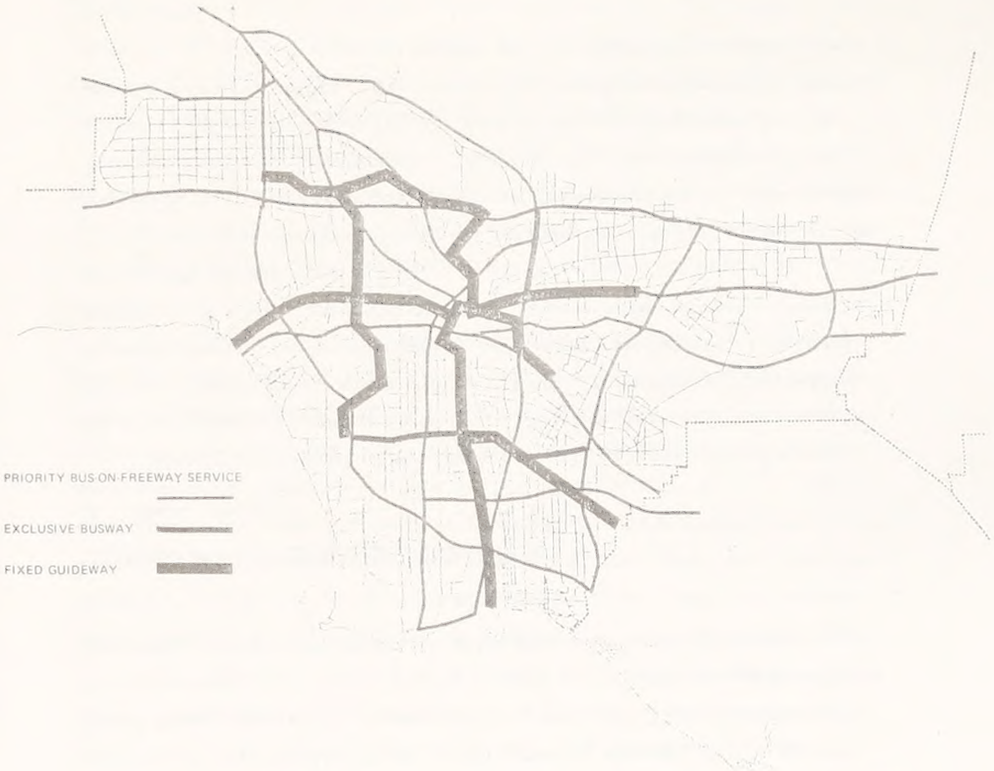
These measures are designed to attract a greater number of passengers by (1) making bus travel more convenient, (2) expanding the frequency of bus service, and (3) expanding the area served by bus service. Under the proposal, passengers will be able to drive to centrally located terminals and ride a bus to work. By attracting commuters in outlying areas, it is hoped that reductions in air pollution and freeway congestion can be achieved. In addition, by reducing the number of automobiles which drive to the downtown business district, there will be a reduction in the construction of new parking facilities. At the present time, 30% of the total area in downtown Los Angeles is devoted to parking lots. This is in addition to the 30% used for streets.

The long range SCRTD plans center around the construction of a 121 mile fixed guideway system. This guideway system would service the most heavily populated areas of Los Angeles (see Figure 11), and is the most costly component of the SCRTD proposal. It is estimated that the total costs of the near-term expansion program will run approximately 198 million dollars (through 1977) whereas the total costs for the fixed guideway system are projected to be approximately 6.6 billion dollars. Two thirds of the capital outlay is expected to come from the Federal Government.

A fixed guideway system for the Los Angeles area becomes especially expensive because of the large territory involved. It is asserted that a fixed guideway system, because it runs on electricity, will significantly reduce air pollution in the South Coast Air Basin and particularly in the downtown area. This claim has recently been challenged by some experts who argue that increased emission controls on both motor vehicles and stationary sources of pollution will reduce the volume of air pollutants to acceptable levels regardless of whether a fixed guideway system is constructed.

However, the impact of an integrated mass transit system in the Los Angeles area will be significant. Because such a system will facilitate the movement of people over broad areas of the county, it is expected that reliance on the automobile will decrease. SCRTD estimates that by 1990, some 1,050,000 persons will make daily rapid transit trips. Of this total, 706,000 will be people who would otherwise use automobiles. The most significant reduction in automobile travel will be in the downtown areas.

FIGURE 11



Source: Southern California Rapid Transit District

Currently, about 35% of the work trips made to the central business districts are by public transportation. By 1990 it is estimated that this figure will jump to 65%.

A mass transit system will also open up new employment opportunities because people will be able to travel farther to work (or to find work) thereby making more employment centers accessible and affordable than has traditionally been the case. Because people will be able to live farther from their work, it is expected that the Los Angeles area will maintain its low density levels. However, there will probably be some shift in commercial and industrial setting as businesses move closer to rapid transit lines.

Lastly, the SCRTD proposal will probably lead to a reduction in total energy consumption. According to SCRTD, "rapid transit is at least 6 times more efficient in the use of energy than the automobile." Therefore, assuming from the fact that 706,000 less people will take automobiles to work and assuming that this will lead to approximately 500,000 less automobiles on the road, the energy saved will allow the movement of approximately 4,500,000 people by rapid transit, four times the daily patronage estimated.

While there will be a total reduction in the amount of energy devoted to transportation, there will be an increase in the amount of electricity consumed. But this increase is not expected to be that great -- for Southern California Edison, the amount consumed by rapid transit will be only 2.5% of total electricity sales. And this increase should be more than offset by the increasing fuel available to electric utilities because of the reduction in automobile petroleum consumption. Therefore, while a rapid transit system is expected to lead to an increased consumption of electricity, it is also expected to lead to an even larger supply of electricity generating fuel supplies.

B. Other Transportation Areas

There is currently only one major airport in the six county impact area -- Los Angeles International Airport (LAX). There are also a number of intermediate airports (Long Beach, Burbank, and Ontario) which primarily service intra-state flights. Throughout the past few years, a number of study groups have recommended the construction of an additional international airport at Palmdale in Northeast Los Angeles County. Although it is uncertain whether final approval will be given to the proposed Palmdale airport, if approval is given SCRTD has incorporated a fixed guideway line to Palmdale in its long range planning. A significant increase in motor vehicle travel to the Palmdale area will also occur.

Transportation in the SDG&E Impact Area

A. Mass Transit

Mass rapid transit in San Diego has only progressed to the initial study and alternative planning stages. Like Los Angeles, buses constitute San Diego's public mass transit system. A number of alternatives to public buses have been proposed - - a heavy rail system, a light rail system, and a fixed guideway system. None of these proposals have received official approval.

Current projection for housing patterns indicate that people will be moving farther away from their work as "suburbanization" extends farther into the North County area. This will mean that workers will be traveling longer distances to work and will be spending more time in transit than ever before. Because of this growth away from the downtown areas, any mass transit system will necessarily have to service a large area.

It is estimated that a rapid transit system would attract about 800,000 passengers annually, capturing around 10% of all trips made in the region. With respect to home-to-work trips, the rapid transit system would provide service for about 16% of these trips and around 50% of the home-to-work trips destined for the downtown areas.

Because the future of rapid transit is so tenuous, it is impossible to say with any accuracy when, if at all, construction will begin and what kind of system will finally be approved. For the present, expanding existing bus services will be the primary means for upgrading the mass transit system.

B. Other Areas

There are three airports in San Diego County, two of which are operated by the Navy. The municipal airport, Lindberg Field is an international airport. There are no official plans for building an additional airport.

In December, 1972, the California Legislature passed the "Mills Act" which authorizes $30,000 per month for use by cities and counties for constructing bicycle lanes. San Diego county has received top priority in the use of these funds, receiving some $6,000. Because of the prohibitive costs of constructing separate bicycle paths, San Diego plans to provide special lanes for bicycles on existing roadways.

EFFECT ON ARIZONA

The amount of power which the Arizona companies will receive from Kaiparowits does not represent a large portion of their total supply. However, the aquiring of power as needed does facilitate urban growth and Arizona population centers experience problems generally associated with urbanization and some problems that are somewhat unique to Arizona.

In all the Western states, the aquiring of needed water supplies is an ever present problem; in arid Arizona the problem is acute. However, in the foreseeable future the Phoenix metropolitan area will probably have water as needed because reclamation projects have kept pace with urban growth. See Figure 13.

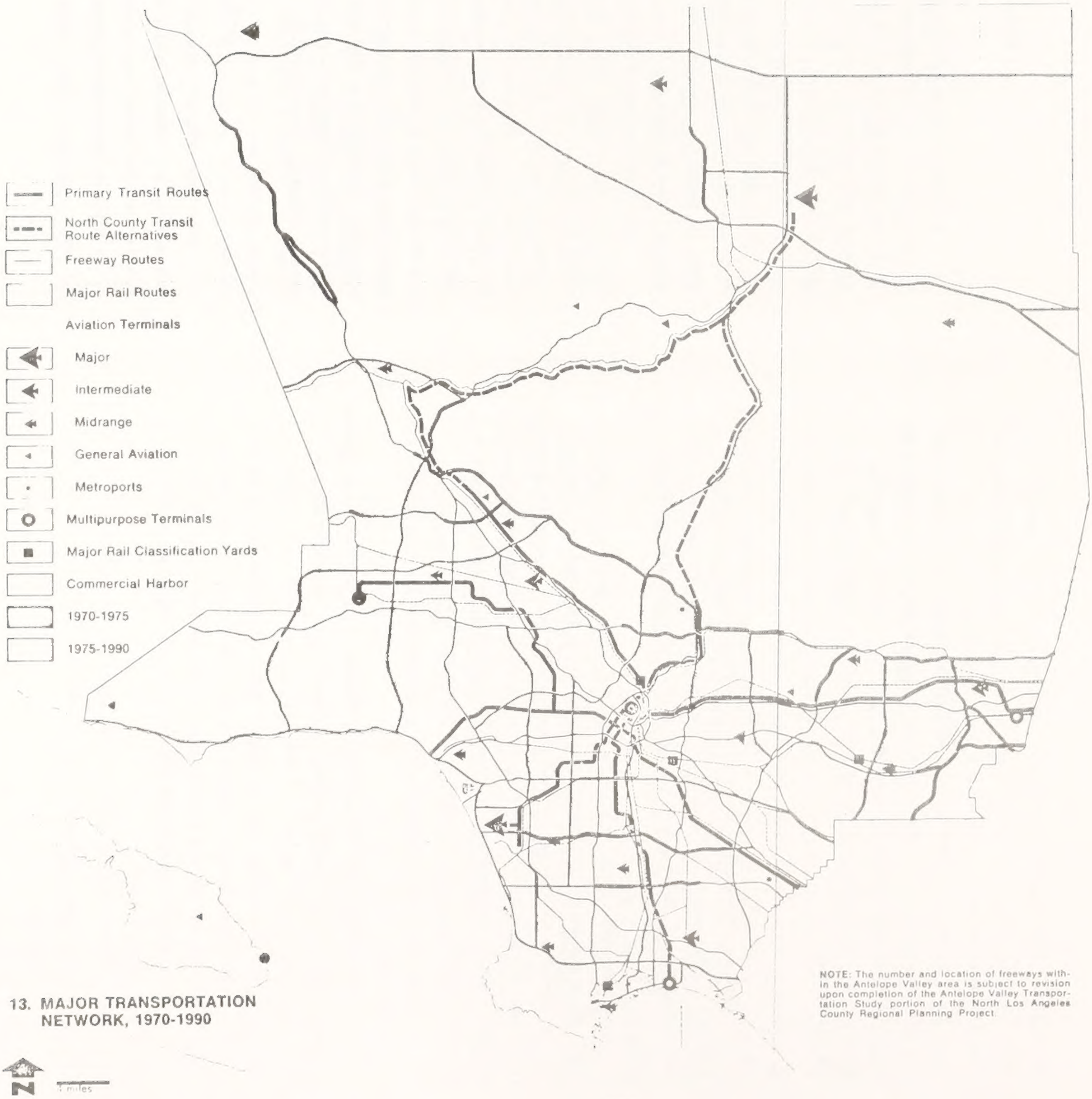
The proposal under consideration calls for the plant to be located near the coal mines in Utah. Cooling processes in the plant will consume about 45,000 acre feet of water per year. The company has acquired rights to water from the Colorado River, from the Utah allocation, to meet this need. Exclusive rights for the water expires in but it is probable that Utah will continue to supply the needed water beyond that year. If the plant were built in Arizona rather than Utah, or if additional plants were built in Arizona using coal shipped from Utah, then Arizona would have to face the problem of providing water supplies for this industrial use. In addition to the need for water for growing populations, four major problems have been selected for this study. They are open space needs, pollution, transportation problems, and community esthetics.

OPEN SPACE

Prior to 1950, the Phoenix economy was based on agriculture. Stockyards, grain fields, and citrus groves filled in the land that immediately surrounded the city. At that time, the Phoenix metropolitan area cities were separated by farmers' fields, and in a few minutes' drive from the city, an urban resident would find ample open space for recreation.

FIGURE 12

Major Transportation Network, Los Angeles County



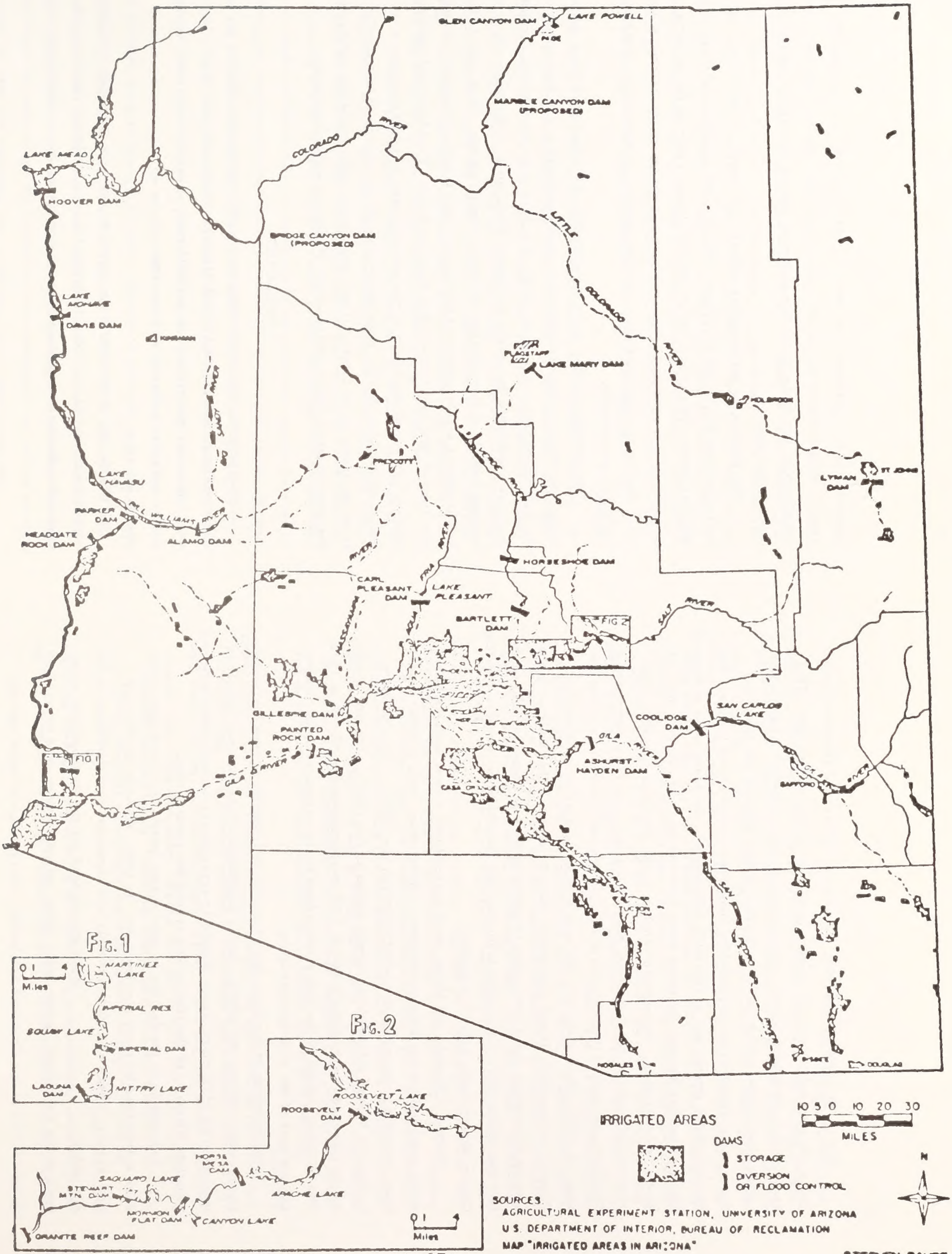
13. MAJOR TRANSPORTATION NETWORK, 1970-1990

NOTE: The number and location of freeways within the Antelope Valley area is subject to revision upon completion of the Antelope Valley Transportation Study portion of the North Los Angeles County Regional Planning Project.

FIGURE 13

MAJOR DAMS AND IRRIGATED AREAS

- 1966 -



SOURCES.
AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF ARIZONA
U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION
MAP "IRRIGATED AREAS IN ARIZONA"

STEPHEN BAHRE

During the 1950's, however, the area in and around Phoenix experienced phenomenal industrial, commercial and residential growth. This agricultural community rapidly turned into a busy, crowded urban center. Large stockyards, which had been located within sight of the downtown area, soon disappeared, replaced by businesses, motels and homes. Extensive citrus groves and grain fields immediately north and west of Phoenix and surrounding Tempe and Mesa were replaced by light industry and residential subdivisions. Farms and ranches in the city's northeast section were purchased and developed into housing tracts. The area surrounding Phoenix experienced the attrition of agriculture and a spread in urbanization. In 1949, there were 475,000 acres under irrigation in Maricopa County, but by 1972, it had dropped to 442,600 acres. This decline in the amount of acreage under irrigation is particularly significant in light of the fact that there were major efforts during that time to bring western Maricopa County desert lands under irrigation.

Tempe, Glendale and Mesa, once agricultural cities, became bedroom communities for Phoenix workers. Scottsdale, once a small desert town, became a westernized tourist resort in the 1960's. Arizona State College in Tempe achieved University status in the 1950's. Student enrollments increased from about 6,000 in 1950 to approximately 30,000 in 1973. The booming growth of the University added to the urbanization of Tempe and the rest of the metropolitan area.

Urbanization of the area decreased the availability of land for recreational use. During the 1950's, as the population of the metropolitan area increased by 311% there was a decline in agricultural activity and a nearly complete filling in of the land in and around the central city.

Responding to the decline in open space, parks and recreation sites were established by local governments. In 1956, Phoenix had 35 such park areas. There are approximately 133 municipal park facilities in the city today. More are planned for the metropolitan area, such as the so-called "green-belt" area, an open-space area covered by natural desert vegetation supposed to stretch east to west through the SMSA. Neighborhood parks are established when new housing tracts are constructed, but these parks are generally poorly maintained by the city parks department.

The SMSA city governments appear to be trying to maintain a certain degree of open space and recreation sites for the residents of their cities. Whether there will continue to be additional open space in the growing urban area is dependent on the activities and wishes of the residents and their political representatives. But the creation of more park areas in the SMSA is probable.

Two positive trends in the maintenance and creation of open space within the Phoenix metropolitan area have developed in the first years of the current decade. Residents of the city have seen once-scenic landmarks (such as Camelback Mountain and Squaw Peak north of the main urban area) become heavily encroached on by housing development. This construction has become a highly controversial issue; as a result, a moratorium on this type of land development has been declared. Residents and political leaders are becoming aware of the growing need to preserve land in local mountain areas as parks, open space that all can enjoy. If this continues to be the trend in the future, it will doubtlessly affect land use policy of the governmental bodies in the entire Phoenix metropolitan area.

POLLUTION

Before 1950, there was little pollution of the environment in the vicinity of Phoenix. Blowing dust from farmers' fields and odor from stockyards were the major contributors to air pollution. Because industrial, residential or vehicular pollution was considered to be no problem, records of this do not exist.

The decade of the 1950's brought to the SMSA tremendous growth in industry and commerce. New factories, new businesses, and thousands of motor vehicles brought an increase in air pollutants to the SMSA. This is illustrated by the following statistics: in 1951, there were 152,121 motor vehicles registered in Maricopa County; by 1970, a total of 726,709 vehicles were registered in the county, an increase of 378% over the nineteen year period.

By the mid-1960's, urbanization had effectively removed much of the oxygen-producing vegetation from the area. Black Canyon freeway through Phoenix was built in the late 1950's, replacing older city, county and state roads that had had a limiting affect on travel. Major cross-town streets were widened and improved to permit greater use. Sky Harbor International Airport was built about 1960 facilitating air travel and related pollution.

The increase in air travel in the Phoenix area, the decrease in bus travel within the metropolitan area and the concomitant rise in vehicular travel had all added to the rise in pollution of the surrounding environment. Airline exhaust accounts for the second-highest source of transportation-related pollution in the Phoenix metropolitan area, after automotive pollutants. This has increased the air and noise pollution levels in the area. The increased availability of effective commercial, domestic and vehicular air conditioning units enhanced the reputation of Phoenix as a year-round residence. What had once been a haven for farmers and people convalescing from respiratory ailments became, by the late 1950's, a booming center of industry, commerce and population. In the mid-1960's, air pollution became a serious issue.

The Maricopa County Department of Health Services, Bureau of Air Pollution was created by statute in 1964, as part of a continuing effort to control pollution of the air in the county. The largest part of the air pollution problem is located in the Phoenix SMSA. This is also where most of the effort at control is located. In the fiscal year 1949-50, 91.3 million gallons of motor fuel were consumed in Maricopa County. By 1970, 479.9 million gallons of motor fuel were consumed in the county. Approximately 75% to 80% of this was used in the Phoenix SMSA causing a concentration of air pollution in that area.

One trend found by the Bureau of Air Pollution was that the maximum levels of gaseous pollutants are reached in the winter months of November through February when air stagnation conditions are most prevalent. Table 11 shows trends for concentration of gaseous pollutants from 1967 to 1973. The figures for air quality in the suburban cities of the SMSA would reflect lower levels of gaseous pollutants. This is a result of their location away from the heavily industrial inner city.

Increased tourism, the building of adult retirement communities around the SMSA, the increasing development of freeways in the area, the multiplication of electronics manufacturing plants, and expanded air travel will probably increase the problem of environmental pollution in Phoenix. Demands will be placed on the services of local government bodies to solve the increasing pollution, and it seems that the Bureau of Air Pollution will be the agency most heavily involved in future efforts at problem solving. They have had some success in controlling pollution levels since 1967; this may not continue in the future if urban growth accelerates.

Concurrent with the deterioration in air quality has been the problem of increasing the supply of water and sewage treatment facilities. Central Arizona Project is constantly striving to meet the water demands of the Phoenix area residents, and to date the Project has been most successful. Sewage treatment facilities have been expanded to meet the increasing supply of raw sewage. Local city water departments are coping with the problem by planning and constructing more such facilities as the need arises.

Since the Phoenix SMSA and western Arizona are a desert region, there are very few natural or man-made bodies of water to be affected by pollution. Those that do exist, such as the system of reservoirs northeast of Phoenix are used for recreational purposes as well as for human consumption, irrigation, and industry in the metropolitan area. After being treated in area sewage plants, waste water is discharged into the now dry Salt River so no effluent mixes with the nearby fresh water supply. Much of the water for western Arizona comes from the Colorado River or from deep water wells near towns and cities. These sources have remained nearly free of man-caused pollution in the past; they should remain so in future years, provided that increased urbanization along the Colorado River is planned in such a way as to develop sufficient water/sewage treatment facilities.

Noise pollution is another consequence of the urbanization of the Phoenix SMSA. Prior to 1950 the metropolitan area was an agricultural area; what noise did occur was negligible. The lack of statistical information reflects this fact. Concern about noise pollution (decibel levels) resulted in several studies during the early 1970's. Noise monitors indicated freeway, airport, and major street intersections were problem areas. Attempts to decrease this have been made by the installation of various kinds of devices at the airport and on the freeway. The effectiveness of these is under investigation.

TRANSPORTATION

The only major routes for vehicular travel to and from Phoenix in 1950 were two-lane highways that entered Phoenix from the southwest, northwest, southeast and east. In the urban area, no freeway system had yet been constructed. All traffic within the city was routed on the existing city streets.

The first change in this situation came in the late 1950's with the construction of the Black Canyon freeway through the western area of urban Phoenix. As the metropolitan area grew, so did the need for improved mass transportation facilities in and through the SMSA. Two major interstate freeways connect Phoenix with other points in Arizona at the present time. Interstate 10 is still incomplete. Plans for construction were halted in 1973 following court action and legislative referenda initiated by citizen groups concerned with air, noise, and esthetic pollution.

Since 1887, public transportation services have existed in the downtown Phoenix area. Horse-drawn cars were replaced by electrically operated streetcars. In 1948, the city sold its streetcars converting all services to motor vehicle (bus) operations. In 1959, the city bus system was sold to a private group which operated it as part of the Valley Transit Lines. In 1966, this bus company was sold to the Phoenix Transit Corporation.

Residential preferences for private cars, service cuts and fare increases have produced a decline in public transportation patronage in the metropolitan area. Table 11 shows the yearly decrease in persons utilizing the bus system as a method of transportation in the Phoenix SMSA. Traffic congestion, inadequate parking facilities and air pollution problems have generated discussion and studies to relieve the situation, but no major decisions have been made. Continental Trailways and Greyhound Bus Lines serve the area with intra-state and interstate bus travel, as well as offering intra-metropolitan service to Phoenix area residents, but they do not compete with the automobile as the prefered mode of travel.

In the late 1950's construction began to enlarge and expand airline facilities at the Phoenix municipal airport. Commercial jet service started in 1958. In 1970 the Phoenix airport (Sky Harbor) became an international arrival and departure facility. Table 11 shows that growth in terms of total passengers enplaned and deplaned. At the present time seven major commercial airlines provide passenger service. The Sky Harbor facilities are also used by private, commercial freight, and military aricraft.

About 9 other airports exist in the SMSA. Two of these, Luke and Williams, are Air Force Bases. The other seven are primarily for private aircraft use. Traffic at each has increased as aircraft use has become more popular in the past several years.

Passenger service provided by the Southern Pacific railroad was started in the Phoenix area in the late nineteenth century. That service grew over the years, with the addition of lines to northern Arizona and the Grand Canyon. By the 1950's, however, travel by automobile and airplane had caused a decrease in the number of passengers on the railroad. Today, with the Amtrack Corporation assuming railroad operations in the area, there seems to be revitalized interest in the railroad as a means of personal transportation. If Amtrack continues to increase the quantity and quality of passenger services, future years will probably see the railroad become a popular method of passenger travel once more.

Because of its tremendous rate of growth in the past twenty-four years, Phoenix and its surrounding cities have shared a number of problems: pollution, lack of open space for recreation, and poor transportation. Work has been continuing since the late 1950's on most of these problems; some success has occured, some failure has slowed down ultimate solutions. Since the metropolis is projected to continue growing at a high rate, the problems will not disappear. Unless residents and civic leaders cooperate in finding solutions, Phoenix will face problems parallel to those of larger metropolitan areas.

COMMUNITY ESTHETICS

Within the Phoenix area community esthetics vary greatly. In some areas attention is given to conservation of indeginous vegetation, control of outside advertising, and archeticural design standards. In other areas standards are non-existent. Although the esthetic standards are in part the result of local initiative, there is a double standard which discriminates. Some businessmen participate in activities in neighborhoods which deteriorates the community esthetics in ways they would not tolerate in their own neighborhood. The sharp distinction between the quality of different neighborhoods helps cause increased pollution and transportation problems because it encourages greater suburbanization. Those who work in Phoenix may have to commute long distances to find quality areas in which to live.

The Phoenix area is experiencing a pattern of growth similar to that of Los Angeles. Build up in the central city area is accompanied by urban sprawl and suburbanization with high reliance on the automobile. A lack of an aggressive mass transportation policy encourages even greater dependence on automobile transporation and an over-abundance of automobiles will determine the nature of land-use.

Yuma and Flagstaff are not major urban centers, but they are experiencing problems that accompany growth. There is a general deterioration of the environment in and around the communities. In Yuma the local planning department is aware of problems related to maintaining and improving the esthetic qualities of the city.

Flagstaff, being located in a pine forest, has a unique opportunity to use the indeginous vegetation to enhance community esthetics. However, the city is following an established pattern of clearing out complete areas of the forest for commercial development and is not near as attractive as a few protective measures could insure.

Several desirable facilities, such as mass transportation, are inadequate or lacking, in the utility service area outside of Phoenix. However, except for the Phoenix area, pollution problems are not widespread yet.

TABLE 11

PHOENIX GROWTH STATISTICS - 1973

	1956-57	1960-61	1970-71	Estimated 1972-73	Estimated 1973-74
AREA (Square Miles)	36.3	191.1	254.9	269.3	269.3
POPULATION (Estimated June 30)	172,569	451,964	620,750	723,700	771,800
AUTHORIZED EMPLOYEES*					
(Per 1,000 Population)					
Governmental	9.1	7.2	7.9	8.4	8.5
Public Enterprise	1.4	0.9	1.1	1.1	1.1
POLICE					
Police Employees	264	618	1,273	1,523	1,632
Major Crimes (Crime Index Offenses)	3,560	10,498	31,075	36,600	43,150
Traffic Accidents	6,600	13,500	22,765	29,700	34,100
FIRE					
Fire Stations	12	21	30	30	31
Calls for Service	2,400	6,400	14,347	15,485	20,000
BUILDING INSPECTIONS					
Total Permits Issued ($000)	32,087	87,500	268,585	400,000	400,000
Total Number of Inspections***	75,336	195,205	236,000	319,000	359,000
TRAFFIC CONTROL AND LIGHTING					
Signalized Intersections	146	285	423	440	458
Street Lights in Use	7,800	15,600	23,097	25,000	25,800
Miles of Major Streets Lighted	64	134	155	172	216
STREETS					
Total Miles	756	1,496	2,270	2,424	2,545
Miles Cleaned	45,000	110,000	165,880	174,000	174,000
Miles Resurfaced and Sealed by Contract	26.0	42.0	378.0****	354.1****	224.2****
REFUSE COLLECTION					
Residences Served	50,000	141,000	204,800	243,000	258,000
Refuse Collected (Tons)	87,460	200,435	325,300	420,000	470,000
SANITARY SEWERS					
Connections	35,000	90,000	169,255	203,000	215,000
Miles of Lines	444	965	2,090	2,370	2,520
LIBRARIES					
Book Circulation	648,505	1,221,412	2,368,232	2,410,877	2,601,382
Total Bookstock	191,884	243,904	704,940	790,985	903,772
MUNICIPAL PARKS					
Park Areas	35	48	121	129	133
WATER					
Connections	60,650	122,073	172,100	210,000	225,000
Production (Billions of Gallons)	16.7	33.8	52.7	60.7	64.1
AVIATION					
Passengers Enplaned and Deplaned	535,000	864,000	2,925,700	3,752,000	4,127,000
VEHICLES IN SERVICE					
Total Vehicles in Service	739	1,434	2,673	3,146	3,369

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*Full Time Equivalent Positions, Excluding PEP Employees

**1972 FBI Crime Reporting Format

***Building, Electrical, Mechanical, Plumbing

****Local Street Equivalents

Gaseous Pollutants, 1973

(Continuation of Table 11)

SAMPLER	LOCATION	POLLUTANT	ANNUAL AVERAGE Jan.1 - Dec.31			CONCENTRATION			
CITY	STREET		1973	1972	1971	1970	1969	1968	1967
CENTRAL PHOENIX	1345 E. ROOSEVELT	SULFUR DIOXIDE	8.9	9.0	11.9	13.5	16.5	9.9	---
CENTRAL PHOENIX	1845 E. ROOSEVELT	CARBON MONOXIDE	3,025	4,157	3,892	4,730	5,808	7,306	8,128
CENTRAL PHOENIX	1845 E. ROOSEVELT	NITROGEN DIOXIDE	70.1	80.5	59.1	53.8	43.9	67.4	73.8
CENTRAL PHOENIX	1845 E. ROOSEVELT	OXIDANTS	45.4	33.9	31.9	26.9	41.2	53.6	63.9
CENTRAL PHOENIX	1845 E. ROOSEVELT	TOTAL HYDRO-CARBONS	967.0	1056.0	1178.0	1113.0	1390.0	1515.0	1600.0
CENTRAL PHOENIX	1845 E. ROOSEVELT	SUSPENDED PARTI-CULATES	157.7	159.3	168.7	176.8	120.5	144.0	----

YEARLY BUS TRANSIT PATRONAGE

PHOENIX TRANSIT CORP. AND PREDECESSOR COMPANIES

YEAR	REVENUE PASSENGERS*
1960	9,309,573
1961	8,785,691
1962	6,415,263**
1963	7,813,739
1964	7,366,656
1965	6,917,424
1966	7,419,175
1967	5,180,372
1968	5,131,331
1969	4,437,837
1970	4,091,581

*Includes passengers carried on charter services.

**There was a 56-day strike.

Source: Phoenix Urban Area Public Transportation Study, DeLeuw, Cather & Co., Consulting Engineers, Chapman Press, San Francisco, Circa 1972.

Gaseous Pollutants, 1973

(Continuation of Table 11)

SAMPLER	LOCATION	POLLUTANT	ANNUAL AVERAGE Jan.1 - Dec.31				CONCENTRATION		
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Source: Phoenix Urban Area Public Transportation Study, DeLeuw, Cather & Co., Consulting Engineers, Chapman Press, San Francisco, Circa 1972.

III. Summary and Conclusions

SUMMARY AND CONCLUSIONS

The basic premise of this report has been that the availability of more electrical energy in the service areas of the four Kaiparowits utilities will facilitate urban growth. Based on past trends in the service areas, especially those parts of the service areas with the greatest population, it is argued that growth will continue to be primarily in the form of suburban sprawl.

Through the discussion of open space, pollution, and transportation a picture of present problems and issues of urban life has been presented. The inescapable conclusion is that the greater the growth in the service areas the more difficult it will be to address currently identified problems, let alone those produced by the increased growth. The multiplicity of governmental jurisdictions, especially in Southern California, makes the development of coherent, area-wide policy extremely difficult to accomplish. The Arizona service area, particularly the Phoenix SMSA does not face quite this problem simply because there are fewer people and fewer governmental jurisdictions.

The central issue is growth -- how much, how fast, and where located. One of the very basic conflicts inherent in the discussion of policy on growth was succinctly stated by the Los Angeles County General Plan (1973):

> "If growth occurs mostly in the suburbs, open lands will be lost, extension of freeways and other services will be required, and an opportunity to inject some of the vitality of this growth into older, declining areas will be lost. On the other hand, if development is limited to the inner city, there will be decreased opportunities to enjoy the single family residence life style which is so highly desired by many people."

The General Plan then argues for a "balance" between growth in the suburbs (in other words sprawl) and growth within the older urban sections. This call for balance is a fairly typical response to the conflicts over growth policy in urban areas. The net result is that growth policy decisions are preeminently political decisions. They are fought out in a political arena where the various groups and individuals with an interest at stake seek to influence the decision. In the past, those groups which benefit from relatively unrestrained growth have carried the day.

Straight-line extrapolation of present growth trends (suburban sprawl) is the most energy consuming and quality of life threatening of possibilities open to the service areas. Decisions about growth policy will be made by all levels of government, but the most basic decisions must be made at the local level. Decisions about land use, building codes, and regulation of esthetically obnoxious development are primarily made by local government. And yet there is little evidence of a willingness by local officials to implement any specific policy designed to avoid the potentially calamitous consequences of allowing present trends to continue. With an issue like growth it is impossible not to decide. A decision not to develop a growth policy is in fact a decision to allow the private sector a relatively free and uncoordinated hand in shaping future growth, and therefore the quality of urban life.

In determing how the service areas will grow, decisions about the consumption of electricity are also being made. Urban areas are the greatest consumers of all sources of energy, including electricity. At the same time, the potential for electricity conservation is also the largest in urban areas. For instance, during the period of January - August 1974 all customers of SCE reduced their consumption except the agricultural sector.

The simple fact of more growth does not necessarily translate into an identical amount of growth in electrical consumption. The amount of increase in consumption is subject to control depending upon the kind of decisions made by government and the private sector. Where a person lives, in what kind of residence, how he gets to work, and where he goes for his leisure time activity are all factors which influence rate of growth in electrical consumption. At the same time these factors are amenable to modification by appropriate public policy.

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MAJOR CONTACTS

1.	Jack Nevitt	Air Pollution Control Board
2.	Ken Gray	Bureau of Land Management
3.	John Johnson	California Public Utilities Commission
4.	Phyllis Sommars	" " " "
5.	Brent Hennington	Los Angeles County Department of Parks and Recreation
6.	Dr. Ron Doctor	The Rand Corporation
7.	Bill Bamburg	San Diego Comprehensive Planning Organization
8.	Richard Tenant	San Deigo County Park Development Division
9.	Gregory Nesbitt	San Diego Gas and Electric
10.	Brian Farris	Southern California Association of Governments
11.	Vic Magistrallo	" " "
12.	Mary Bush	Southern California Edison
13.	Roger Day	" " "
14.	Dr. Michael Hertel	" " "

APPENDIX III - 13

The Reclamation Development Act of 1974

Public Law 93-493
93rd Congress, H. R. 15736
October 27, 1974

An Act

To authorize, enlarge, and repair various Federal reclamation projects and programs, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be known as "The Reclamation Development Act of 1974".

The Reclamation Development Act of 1974.

TITLE I

INCORPORATION OF PAGE, ARIZONA

Page, Arizona, Community Act of 1974.

SEC. 101. It is the purpose of this title to separate that unincorporated area in Coconino County in the State of Arizona, commonly known as the town of Page, Arizona, from the Colorado River storage project in order that the United States may withdraw from the ownership and operation of the town and the people of that area may enjoy self-government, and to facilitate the establishment by the people of a municipal corporation under the laws of the State of Arizona by the transfer of certain Federal property described in section 103 of this title.

Definitions.

SEC. 102. The following definitions shall apply to terms used in this title.

(a) The area referred to herein as Page, Arizona, includes the following described land:

PAGE TOWNSITE, ARIZONA

GILA AND SALT RIVER MERIDIAN, ARIZONA

	Acres
Township 40 north, range 8 east:	
Section 1. All	638.94
Section 2. East half southwest quarter, southeast quarter	240.00
Section 11. East half	320.00
Section 12. All	639.38
Township 41 north, range 8 east:	
Section 25. South half southwest quarter southeast quarter, southeast quarter southeast quarter	60.00
Section 36. East half, south half northeast quarter northwest quarter, east half southwest quarter northwest quarter, southeast quarter northwest quarter, northeast quarter southwest quarter, east half northwest quarter southwest quarter, south half southwest quarter	540.00
Township 40 north, range 9 east:	
Section 4. All	639.48
Section 5. All	639.84
Section 6. All	622.74
Section 7. All	623.68
Section 8. All	640.00
Section 9. All	640.00
Section 10. East half southwest quarter, southeast quarter	240.00
Section 20. South half	320.00
Township 41 north, range 9 east:	
Section 21. West half southwest quarter, west half southeast quarter southwest quarter, southeast quarter southeast quarter southwest quarter, southwest quarter southwest quarter southeast quarter	120.00
Section 28. West half northeast quarter, northwest quarter southeast quarter northeast quarter, south half southeast quarter northeast quarter, west half, southeast quarter	590.00

PAGE TOWNSITE, ARIZONA—Continued

GILA AND SALT RIVER MERIDIAN, ARIZONA—Continued

Township 41 north, range 9 east:—Continued	Acres
Section 29. All	640.00
Section 30. All	641.20
Section 31. All	642.00
Section 32. All	640.00
Section 33. All	640.00
Total	10,717.56

Boundary drawing on file.

The boundary of Page, Arizona, is shown on drawing numbered 557-431-83, entitled "Page, Arizona, Townsite Boundary" which is on file in the Office of the Commissioner of Reclamation, Washington, District of Columbia.

(b) The term "municipality" shall mean Page, Arizona, after its incorporation as a municipality under the laws of the State of Arizona.

(c) The term "Secretary" shall mean the Secretary of the Interior.

(d) The term "municipal facilities" shall mean certain land, and the improvements thereon, in Page, Arizona, such as hospital, police, and fire protection systems, sewage and refuse disposal plants, water treatment and distribution facilities, streets and roads, parks, playgrounds, airport, cemetery, municipal government buildings, and other properties suitable or usable for local municipal purposes, including any fixtures, equipment, or other property appropriate to the operation, maintenance, replacement, or repairs of the foregoing, which are owned by the United States and under the jurisdiction of the Department of the Interior, Bureau of Reclamation, on the date of incorporation of Page, Arizona.

Land, improvements, facilities, activities and functions, transfer; leases and contracts, assignment.

SEC. 103. Upon incorporation of Page, Arizona, as a municipality under the statutes of the State of Arizona, the Secretary shall:

(a) Transfer to the municipality without cost, subject to any existing leases granted by the United States, all improved or unimproved lands within Page, Arizona, owned by the United States, which the Secretary determines are not required in the administration, operation, and maintenance of Federal activities within or near Page, Arizona, and can properly be included within the municipality under the laws of the State of Arizona, except the land to be transferred pursuant to subsection (c) hereof, and to assign to the municipality without cost any leases granted by the United States on such land.

(b) Transfer to the appropriate school district without cost all right, title, and interest of the United States to the land in block 14-A and lot 1, block 16, as shown on the United States Department of the Interior, Bureau of Reclamation drawing numbered 557-431-87, April 29, 1971, which drawing is on file in the Office of the Commissioner of Reclamation, Washington, District of Columbia, together with improvements thereon owned by the United States at the time of the transfer.

(c) Transfer to the municipality without cost all rights, title, and interest of the United States in and to any land, and the improvements thereon, which may be contained in any reversionary clause of any dedication deed for land in Page, Arizona, issued by the United States.

(d) Transfer all activities and functions of a municipal character being performed by the United States to the municipality subject to the provisions of sections 104 and 107 of this title.

(e) Transfer to the municipality without cost the municipal facilities, as defined in subsection 102(d) of this title, except as provided under subsection 104(a) of this title.

(f) Assign to the municipality without cost those contracts to which the United States is a party, and which pertain to activities or functions to be transferred under subsection (c) of this section and are properly assignable. This shall include contracts for furnishing water outside the boundaries of Page, Arizona, utilizing the municipal system: *Provided*, That the contract which the United States has executed with a private utility for furnishing and distributing electrical energy to the municipality shall be assigned to the municipality upon its request: *And provided further*, That in the assignment of the contract for the operation of the Page Hospital the operating fund balance under said contract, together with all hospital accounts receivable, shall be transferred to the municipality for the same purpose as a part of the assignment of said contract.

Water supply, contract.

SEC. 104. There is hereby reserved for the Glen Canyon unit, Colorado River storage project, the consumptive use of not to exceed three thousand acre-feet of water per year from Lake Powell, of which not to exceed two thousand seven hundred and forty acre-feet of consumptive use of water are hereby assigned to the municipality, consistent with the Navajo Tribal Council resolution numbered CJN-50-69, dated June 3, 1969: *Provided*, That upon incorporation the municipality shall enter into a contract satisfactory to the Secretary covering payment for and delivery of such water pursuant to the Colorado River Storage Project Act of June 11, 1956 (70 Stat. 105), which contract shall among other things provide that:

43 USC 620.

(a) The reservation and assignment of the consumptive use of water from Lake Powell under this section shall be subject to the apportionments of consumptive use of water to the State of Arizona in article III of the Colorado River Compact and article III(a)(1) of the Upper Colorado River Basin Compact.

(b) Title to the water pumping and conveyance systems within the Glen Canyon Dam and powerplant necessary to supply water to the municipality for culinary, industrial, and municipal purposes shall be retained by the United States until the Congress provides otherwise.

(c) Such retained facilities shall be operated and maintained by the Secretary at the expense of the United States until termination of the fifth fiscal year following the year of incorporation. Not to exceed two thousand seven hundred and forty acre-feet of water per annum or three million gallons of water in any twenty-four-hour period, will be pumped by the United States from Lake Powell to the water treatment plant, or to such intermediate points of delivery as shall be mutually agreed upon by the municipality and the United States for use by the municipality.

(d) Beginning with the sixth year following incorporation and continuing through the tenth year, the municipality shall in each year pay to the United States proportionately increasing increments of the annual costs, including depreciation of the pumping equipment, involved in subsection (c) above with the objective that following the close of said tenth year the municipality shall thereafter bear such costs in total, according to the following schedule:

Year following incorporation:	Portion of cost in subsection (c) of section 104 to be paid to United States each year by municipality (per centum)
Sixth	20
Seventh	40
Eighth	60
Ninth	80
Tenth	80
Thereafter	100

(e) Upon incorporation and at all times thereafter, the municipality shall bear all costs for operation, maintenance, and replacement of the municipal water system beyond Glen Canyon Dam and powerplant, including but not limited to filtration, treatment, and distribution of water supplied pursuant to the water service contract with the United States.

Community programs, completion.

SEC. 105. As soon as reasonably practicable after incorporation of the community, the Secretary is hereby authorized to complete all or any part of the following work which has not been completed at the date of incorporation.

(a) Take census of population of the municipality within one year following incorporation.

(b) Repair existing twelve-inch water supply line, if inspection determines this is necessary.

(c) Paint interior of water storage reservoirs.

(d) Seal coat paved streets in municipality.

(e) Install water sprinkler system in Page cemetery.

(f) Improve streets, install curbs, gutters, and sidewalks as follows:

(1) North Navajo Drive:

(i) Pave streets to seventy-foot width from Ninth Avenue to relocated intersection of Aero Avenue and sixty-one-foot width from Aero Avenue to Tenth Avenue.

(ii) Place curb, gutter, and sidewalk on east side of North Navajo Drive from Aero Avenue to Tenth Avenue.

(2) Aero Avenue from North Navajo Drive to Future Street:

(i) Widen existing thirty-foot paved width to seventy-foot paved width.

(ii) Place curb, gutter, and sidewalk on both sides of street.

(3) Tenth Avenue from Future Street to Sandstone Street:

(i) Construct new pavement on north half of street and overlay south half of street.

(ii) Place curb and gutter only on north side of street.

(4) Future Street—Approximately two thousand one hundred and fifty feet beginning at Tenth Avenue and bordering east side of block 101 as shown on Page townsite and block plats:

(i) Pave street to fifty-two-foot width.

(ii) Place curb, gutter, and sidewalk on west side of street and curb and gutter only on east side of street.

(5) Hopi Avenue from Oak Avenue to west boundary of block 101:

(i) Pave street to forty-two-foot width.

(ii) Place curb, gutter and sidewalk on north side.

(iii) Place curb and gutter only on south side.

(g) Construct paved access road from United States Highway Numbered 89 to site of new sanitary landfill to be located in the northwest quarter, section 20, township 41 north, range 8 east, Gila and Salt River meridian, Arizona: *Provided*, That in the performance of the work authorized in this section, the Secretary may either cause the work to be done or transfer funds to the municipality for this purpose after ascertaining that each segment of work will be accomplished by a date certain and to standards satisfactory to the Secretary.

Payment to municipality.

SEC. 106. (a) Upon incorporation the Secretary is authorized to make a lump-sum payment of $500,000 to the municipality as assistance to the municipality in meeting the expenses of police and fire protection facilities and services, sewage system, refuse disposal, electrical distribution system, water treatment and distribution, streets and roads, library, park, playgrounds and other recreational facilities, municipal government buildings, and other properties and services required for municipal purposes.

(b) To make a lump-sum payment of $50,000 to the municipality for improvements to the Page Hospital.

Federal personnel, services provided to municipality.

SEC. 107. Upon incorporation, the United States will provide to the municipality, upon its request, the services of Federal personnel, while they are employed by the United States in the operation and maintenance of the Glen Canyon unit of the Colorado River storage project, to assist in the transition from a federally administered community to a self-governing municipal corporation: *Provided*, That such assistance shall be for a maximum of six months following the date of incorporation: *And provided further*, That the total number of such employees shall be limited to ten at any time.

Limitations.

Funds, prohibition of additional use.

SEC. 108. (a) Except as herein specifically provided, no assets of the Colorado River storage projects or moneys of the Upper Colorado River Basin Fund shall be utilized after incorporation of the municipality for carrying out the provisions of this Act.

Transfer of funds.

(b) At the election of the municipality, the United States shall make electric power and associated energy available to the municipality from the Colorado River storage project at the 69 kilovolt bus of the existing power substation at scheduled rates effective from time to time for resale by the municipality to an electric utility: *Provided*, That the sale agreement between the municipality and such utility is completed before August 1, 1976: *And provided further*, That in lieu of such purchase and resale, there is hereby authorized to be appropriated from the Upper Colorado River Basin Fund and thereupon transferred to the municipality the amount necessary for the municipality to acquire the electric distribution facilities in Page, Arizona, in the event the municipality decides before August 1, 1976, to acquire said facilities through the exercise of its powers of eminent domain or the amount necessary for the municipality to acquire such facilities in accordance with the terms and conditions of the contract with the utility supplying the electricity, in the event the municipality exercises the option in said contract to acquire said electric distribution facilities: *Provided*, That the municipality agrees to repay with interest the amount of the funds so transferred in twenty equal annual installments: *Provided*, That the funds so repaid and the accrued interest thereon will be deposited in the Treasury to the credit of the aforesaid Upper Colorado River Basin Fund. The interest rate used for computing interest on the unpaid balance of funds transferred to the municipality for purposes of this subsection shall be determined by the Secretary of the Treasury, as of the beginning of the fiscal year in which the incorporation of Page, Arizona, occurs, on the basis of the computed average interest rate payable by the Treasury upon its outstanding marketable public obligations which are neither due nor callable for redemption for fifteen years from date of issue.

Navajo Tribe, transfer of land to be held in trust.

SEC. 109. The Secretary of the Interior is authorized to transfer to the United States to be held in trust for the Navajo Tribe title to a tract of land situated within the southeast quarter of the southeast quarter, section 8, the southwest quarter, section 9, section 16, the east half of the northeast quarter, section 17, section 21, and the northeast quarter of the northeast quarter, section 28, all in township 41 north, range 9 east, Gila and Salt River meridian, Coconino County, Arizona, and containing eight hundred and eight acres, more or less, of which the particular description and drawing (Numbered 557-431-38 "Navajo Tribe—Antelope Creek Recreation Development Area Survey Traverse" dated May 22, 1969) are on file and available for public inspection in the office of the Bureau of Reclamation, Department of the Interior. The transfer of title to such land is made in consideration of Navajo Council Resolution Numbered CNJ-50-69 dated June 3, 1969, and with the understanding that the land so transferred shall thereafter constitute a part of the Navajo Reservation and shall be subject to all laws and regulations applicable to that reservation.

SEC. 110. The Congress hereby directs the Secretary of the Interior to facilitate the effectuation of Navajo Tribal Council Resolutions

CD 108-68 and CJN-50-69, subject to the provisions of the Colorado River Basin Project Act (82 Stat. 885).

43 USC 1501.

SEC. 111. The Secretary is hereby authorized, subject only to the provisions of this title to perform such acts, to delegate such authority, and to prescribe such rules and regulations, and establish such terms and conditions as he may deem necessary and appropriate for the purpose of carrying out the provisions of this title.

Funding.
43 USC 620.

SEC. 112. The Upper Colorado River Basin Fund established pursuant to section 5 of the Act of April 11, 1956 (70 Stat. 105), shall be utilized as appropriate for carrying out the provisions of this title: *Provided*, That the total expenditures from the fund shall not exceed $4,000,000. Payments made under the provisions of section 105 and section 106 of this title, and transfer, made under the provisions of subsection 108(b) will be made from revenues accruing to said basin fund from the sale of power from the Upper Colorado River storage project.

Termination date.

SEC. 113. All authority of the Secretary under sections 101 through 112 of this title shall terminate five years following date of enactment unless incorporation of Page, Arizona, shall previously have been achieved.

SEC. 114. This title may be cited as the "Page, Arizona, Community Act of 1974".

APPENDIX III - 14

Population Forecasting, Tax Revenue, Housing and Public Opinion Poll

APPENDIX III - 14

Socioeconomic Factors

Population forecasting, tax revenue, housing, and public opinion poll

The participant's estimate of basic employment is contained in Chapter I. Basic employment generates "secondary employment." "Secondary" simply means that jobs are generated by the needs of basic employees. The products of basic employment is exported from the area (in this case, power is exported to Arizona and California), whereas the product of secondary employment is consumed by residents within the immediate area.

An "employment multiplier" is the average number of secondary and basic jobs expected to result from creation of the average basic job. Assuming that a new town will be established at the Glen Canyon City area, the expected employment multipliers for three areas are shown in Figure 1. The same figure contains "dependent multipliers" for the same areas. A dependent multiplier is the average number of people dependent upon each job. The figure is smaller than a figure for family size would be, because an average of more than one person is expected to be employed from each family.

Population projections for Page, Arizona based on the influence of the Navajo Plant (without Kaiparowits) are shown in Figure 2.

Criteria for projecting tax revenues

The assessed value of property in Utah for computing property taxes is an average of 20 percent of the real value. This 20 percent figure is then taxed at the rate of .05436. The real value of the plant when completed is expected to be $1,800,000,000. Mine property is currently assessed in Utah by estimating the value of the ore in the ground. However, a task force has made recommendations

FIGURE 1

Population Forecasting Multipliers

For the Kaiparowits Employment

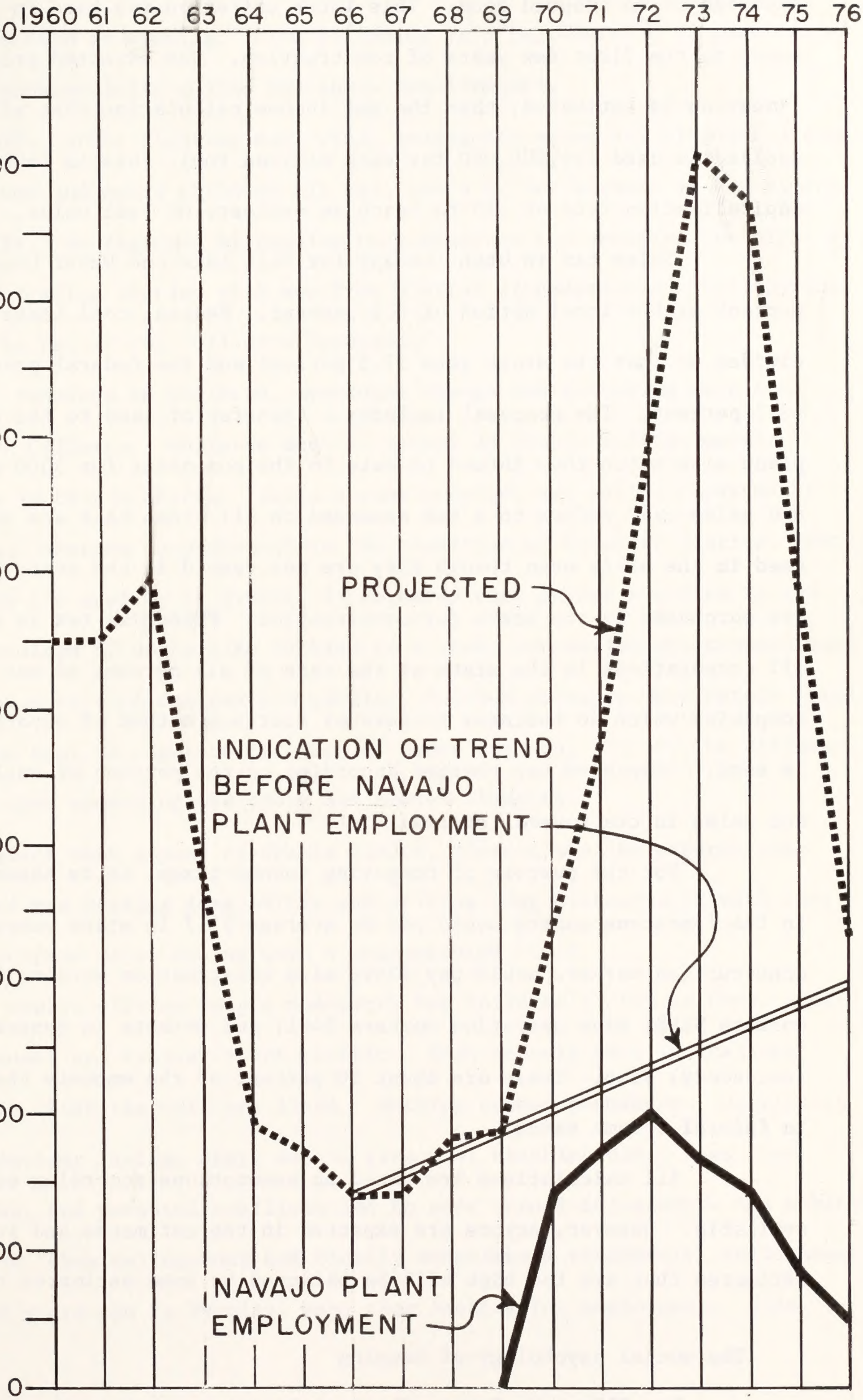
	New Town	Garfield Co.	Page Arizona	
Year 1*	1.15	1.50	2.5	Employment Multiplier
2	1.30	1.56	2.5	
3	1.45	1.62	2.5	
4	1.60	1.68	2.5	
5	1.75	1.74	2.5	
6	1.90	1.80	2.5	
7	2.0	1.86	2.5	
8	2.0	1.92	2.5	
9	2.0	1.98	2.5	
10	2.0	2.04	2.5	

	New Town	Garfield Co.	Page Arizona	
Year 1	1.70	1.75	2.0	Dependent Multiplier
2	1.81	1.80	2.0	
3	1.92	1.85	2.0	
4	2.0	1.90	2.0	
5	2.0	1.95	2.0	
6	2.0	2.00	2.0	
7	2.0	2.05	2.0	
8	2.0	2.10	2.0	
9	2.0	2.15	2.0	
10	2.0	2.20	2.0	

*12 months after construction begins

FIGURE 2

Population Projection for Page, Arizona
Based on Influence of the Navajo Plant



for changing this procedure and a method of computing value based on net income is expected to be adopted soon. This later criterion was used in this study subsequent to the first few years of construction. The expected production of coal and limestone is estimated, then the net income calculation that will probably be applied is used ($4,000,000 for each million ton), this is then divided by the capitalization rate of .15 to reach an estimate of real value.

Sales tax in Utah (except for Salt Lake and Weber Counties) is 4.0 percent with a local option of 0.5 percent. Federal coal lease royalties are divided so that the state gets 37.5 percent and the federal government gets 62.5 percent. The proposal includes a transfer of land to the state for the plant site which they intend to sale to the companies for $300 an acre. "Use and sales tax" refers to a tax assessed on all items that are imported and used in the state even though they are not resold in the state, and items that are purchased in the state for construction. Franchise tax is assessed on all corporations in the state at the rate of six percent of net income. For companies which do business in several states a method of apportioning income is used. Companies are charged according to the portion of employees, investment, and sales in the several states.

For the purpose of computing income taxes, it is assumed that workers in the limestone quarry would pay an average $317 in state taxes a year. Plant construction workers would pay $394; mine construction workers $403; plant operation workers $298; mine operation workers $461; and workers in generated employment (secondary) $216. These are about 10 percent of the amounts that would be paid in federal income taxes.

All calculations are based on assumptions according to the best information available. However, errors are expected in the estimates and it is hoped that some estimates that are too high will be balanced by some estimates that are too low.

The social psychology of housing

Dr. ElDean V. Kohrs, Clinical Director, Central Wyoming Counseling Center, Casper, Wyoming, delivered a paper to a meeting of the Rocky Mountain American Association of the Advancement of Science Meeting, held in 1974, entitled "Social Consequences of Boom Growth in Wyoming." The following is a reproduction of portions of Dr. Kohrs' paper, substantially edited for space requirements.

A housewife, after fighting mud, wind, inadequate water and disposal systems, a crowded mobile home and muddy children all day, snaps at her husband as he returns from a 16-hour shift. He responds by heading back downtown and spending the night at a bar drinking and trading stories with men from similar circumstances. This typical occurence came to be called the "Gillette Syndrome."

Divorce, tensions on children, emotional damage and alcholism were the result of growth in Gillette. Children went to school in double shifts; motels turned over linens in triple shifts. Jails became crowded; and police departments experienced frequent changes in personnel in the tradition of frontier justice. Out of frustration with the quality of living, it appeared that mayors shuttled in and out of office regardless of party like bobbins in a loom. Depression was rampant with suicide attempts at a rate of one per 250 people. Suicide attempts were rarely fatal but they became the tool to regulate the lack of human concern. It was the ultimate method to express that something was wrong and needed changing.

When neglect went beyond tolerable limits, divorce was the natural consequence. Fatigued men working long shifts and driving long distances to work came home to equally fatigued wives coping with a mudspattered world.

Trailer courts offered only a mud-patty for children's play as they raced between trailer houses and trailer court traffic. Even schools were in trailers similar to those in which the children lived. Nothing seemed permanent. Difficulty in coping with transient living, angry school personnel teaching under less than adequate conditions, and parental conflicts led to poor school adjustments and achiements, then truancy, then delinquency and finally sometimes a residential environment.

Like 100 years ago in Wyoming, many came looking for employment. Wide

FIGURE 3

Gillette and Campbell County Statistics

Year	City Population	County Population	Public School Enrollment
1950	2,190	4,839	694
1960	3,580	5,861	968
1968	8,000		2,456
1969-70			2,975
1970-71	7,194	12,957	3,261
1971-72	7,200		2,968
1972-73	8,000		3,146
1973-74	9,000		3,060

1970 Statistics

County	Population	School	Births	Marriages	Divorces	Ratio
Campbell	12,957	3,696	317	130	72	1.8
Carbon	13,354	3,514	237	148	54	2.7
Goshen	10,885	3,178	172	129	39	3.3

Criminal Statistics (1970)

County	Population	Arrests	Public Drunkenness	Driving Under the Influence	Criminal Budget
Campbell	12,957	1,025	134	90	$1,118,597
Carbon	13,354	614	56	20	551,507
Goshen	10,885	337	47	20	419,500

	School Drop-Outs	Drop-Out Rate
	1969-70	1969-70
Campbell	70	5.0
Carbon	52	3.4
Goshen	31	2.3
Wyoming		3.4

open spaces and unlimited employment attracted workers from Florida to California. People worked hard and drank hard. There was little time for release through recreation.

Jails often became a protection of wives from beating by drunken spouses rather than detention for real crime. Psychiatric and alcoholic withdrawal problems were maintained in the jail because of overworked medical personnel and inadequate medical facilities. The hospital was a first-aid station to maintain life until the injured could be transported to a hospital in Casper, Billings or Denver.

The pattern of depression, delinquency and divorce was so well documented that the consequences were predictable. Citizens forsook the pursuit of higher needs in order to cope with the need for adequate water, sanitation, and social survival. An attitude soon developed, "Let it happen; we'll meet the crisis again." Booms are not new in Wyoming, but the social consequences are becoming increasingly clear.

The present study is based on Campbell County. Campbell County is the size of the state of Connecticut and contains one town - Gillette. From 1960 to 1970, the population of the county grew 121 percent. The peak of the most recent boom occurred in 1970. See Figure 3.

Campbell County can be compared to two other Wyoming counties with roughly the same 1970 census population figures. Carbon County grew at a rate of zero percent and Goshen County at a rate of minus 6.7 percent from 1960 to 1970. Campbell County had a significant energy boom. Carbon County had significant changes due to the coal expansion in Manna and uranium at Shirley Basin. Goshen County has continued to be a stable ranch and farm community.

As Figure 3 shows, high employment and the wealth of boom conditions does not mean fewer social problems. In fact the reverse seems to be the case. The comparative figures for divorce rates and criminal statistics are particularly revealing.

The school dropout rate of 5.0 to 6.3 percent in Campbell County far exceeds Carbon, Goshen, and the State of Wyoming as a whole. The move from a stable school environment to one plagued with rapid growth and administrators unfamiliar with such conditions resulted in frequent school personnel--student confrontations. Because of high employment opportunities, many students opted for work rather than continued education unrelated to employment trends.

This issue of boom town is not politics, economics or engineering, but rather human survival at a level above existence, getting along, or even, as good as we have it now.

Since the first oil was found at Salt Creek, power production in Wyoming has wreaked a toll of human suffering, developed opportunities that flared in the boom blaze and died, or flared and continued wildfire growth without care or planning, leaving wakes as devoid of quality life support as a prairie grass burn area.

Details of public opinion poll

Random samples without replacement were taken in each of six communities, however, the proportion of people interviewed differed for each town.

A sampling error of 10 percentage points at the 95 percent confidence level means that for an estimate such as 47 percent there is a 95 percent chance that the true population percentage will fall between 37 and 57 percent. (47% - 10% = 37%) (47% + 10% = 57%).

Three types of hypotheses tests were used. For subpopulation comparisons of responses to questions used for the Page, Arizona sample, chi square tests for contingency tables were employed. A discussion of these tests can be found in Introduction to Mathematical Statistics by Hogg and Craig.

Since the sample design of the southern Utah communities was disproportionate, alternative procedures were used. For comparisons of two mean or percentage estimate, difference-of-means tests were employed. Differences of estimates were assumed to be normally distributed. A discussion of difference-of-means tests were employed. Differences of estimates were assumed to be normally distributed. A discussion of difference-of-means tests can be found in Survey Sampling by Kish.

Break-downs referred to in the text, but not explained in detail are listed on the following pages.

Southern Utah Sample

	Total	Boulder	Cannonville	Escalante	Henrieville	Kanab	Tropic
Total	350	36	40	79	46	87	62
Sex:							
Male	169	18	20	36	23	40	32
Female	181	18	20	43	23	47	30
Age:							
18-29	70	13	5	10	12	13	17
30-39	53	2	5	12	6	18	10
40-55	69	5	11	16	12	16	9
Over 55	158	16	19	41	16	40	26
Income:							
Under $8,000	194	24	28	52	24	31	35
$8,000 and over	152	12	12	25	22	54	27
Occupation:							
Professional and Business	86	11	7	13	3	33	19
Manual	156	22	16	32	32	27	27
Retired	106	3	17	34	9	27	16

Page Sample

Total	374
Residence:	
Trailer House	261
Apartment	42
Private Home	71
Sex:	
Male	184
Female	190
Age:	
18-29	111
30-39	99
40-55	111
Over 55	52
Income:	
$15,000 or less	129
Over $15,000	240
Occupation:	
Professional and Business	113
Manual	249

SOUTHERN UTAH

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Totals	76%	20%	4%
Sex:			
Male	78	16	7
Female	76	24	1
Age:			
18-29	75	23	2
30-39	83	17	0
40-55	77	18	5
Over 55	74	20	5
Income:			
Under $8,000	76	18	6
Over $8,000	79	21	1
Occupation:			
Professional and Business	76	22	2
Manual	76	21	3
Retired	78	17	5
Area:			
Cannonville	85	15	0
Tropic	92	3	5
Henrieville	85	15	0
Boulder	61	36	3
Escalante	85	10	5
Kanab	69	28	3

DO YOU FAVOR A SLIGHT OR SUBSTANTIAL INCREASE IN POPULATION?

	Slight	Substantial
Total	38%	35%
Sex:		
Male	40	38
Female	36	32
Age:		
18-29	35	36
30-39	42	37
40-55	30	42
Over 55	40	31
Income:		
Under $8,000	37	32
$8,000 and over	38	40
Occupation:		
Professional and Business	34	37
Manual	37	37
Retired	42	31
Area:		
Boulder	42	19
Cannonville	43	35
Escalante	44	37
Henrieville	41	41
Kanab	33	31
Tropic	39	52

SOUTHERN UTAH

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SLIGHTLY?

	Favor	Oppose	Don't Know
Totals	54%	36%	7%
Sex:			
Male	63	30	7
Female	48	46	6
Age:			
18-29	56	38	6
30-39	66	34	0
40-55	53	35	12
Over 55	50	42	7
Income:			
Under $8,000	51	40	9
Over $8,000	60	37	3
Occupation:			
Professional and Business	52	46	3
Manual	60	32	8
Retired	51	41	8
Area:			
Cannonville	78	20	2
Tropic	69	26	5
Henrieville	70	28	2
Boulder	44	53	3
Escalante	63	28	9
Kanab	45	48	7

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SUBSTANTIALLY?

	Favor	Oppose	Don't Know
Totals	27%	66%	8%
Sex:			
Male	27	64	9
Female	26	68	6
Age:			
18-29	26	67	6
30-39	22	77	1
40-55	31	59	10
Over 55	27	64	9
Income:			
Under $8,000	27	61	12
Over $8,000	27	70	2
Occupation:			
Professional and Business	27	70	2
Manual	23	68	8
Retired	30	59	11
Area:			
Cannonville	45	50	5
Tropic	39	55	6
Henrieville	30	61	9
Boulder	17	81	3
Escalante	32	58	10
Kanab	21	72	7

SOUTHERN UTAH

DO YOU ANTICIPATE CHANGING YOUR EMPLOYMENT IF THIS COMMUNITY GROWS SUBSTANTIALLY?

	Yes	No	Don't Know
Totals	26%	73%	2%
Sex:			
Male	26	72	2
Female	26	73	2
Age:			
18-29	49	50	1
30-39	36	61	3
40-55	26	70	3
Over 55	13	86	1
Income:			
Under $8,000	23	76	1
Over $8,000	29	68	2
Occupation:			
Professional and Business	23	73	4
Manual	45	54	1
Retired	5	95	0
Area:			
Cannonville	45	55	0
Tropic	36	63	2
Henrieville	56	39	4
Boulder	8	92	0
Escalante	29	72	0
Kanab	20	78	2

WHICH DO YOU BELIEVE IS MOST IMPORTANT IN THIS AREA:

	Economic Development	Environmental Conservation	Both	Don't Know
Totals	61%	13%	21%	5%
Sex:				
Male	70	8	19	3
Female	53	17	22	8
Age:				
18-29	52	28	19	1
30-39	49	15	30	6
40-55	65	10	20	4
Over 55	67	8	18	8
Income:				
Under $8,000	64	11	18	8
Over $8,000	57	16	24	3
Occupation:				
Professional and Business	43	15	37	5
Manual	69	14	14	3
Retired	67	11	13	9
Area:				
Cannonville	65	5	22	8
Tropic	76	2	14	8
Henrieville	70	11	13	6
Boulder	56	11	17	17
Escalante	77	6	15	1
Kanab	49	20	25	6

DO YOU APPROVE OR DISAPPROVE OF OUTSIDE INTERESTS INVESTING MONEY IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Totals	83%	13%	4%
Sex:			
Male	87	12	1
Female	79	14	8
Age:			
18-29	81	16	4
30-39	81	15	3
40-55	86	11	3
Over 55	82	11	7
Income:			
Under $8,000	82	12	6
Over $8,000	83	13	4
Occupation:			
Professional and Business	82	15	3
Manual	81	15	4
Retired	86	7	7
Area:			
Cannonville	70	20	10
Tropic	86	8	6
Henrieville	80	11	9
Boulder	56	39	6
Escalante	90	8	2
Kanab	82	14	5

DO YOU FAVOR OR OPPOSE THE RECRUITMENT OF MINORITY GROUPS (SUCH AS INDIANS) TO WORK IN LOCAL POWER PLANTS?

	Favor	Oppose	Don't Know
Totals	83%	13%	4%
Sex:			
Male	83	12	5
Female	84	13	3
Age:			
18-29	86	12	2
30-39	84	14	3
40-55	80	12	7
Over 55	84	12	4
Income:			
Under $8,000	84	12	3
Over $8,000	83	12	5
Occupation:			
Professional and Business	79	18	3
Manual	86	10	4
Retired	84	11	5
Area:			
Cannonville	82	12	5
Tropic	73	24	3
Henrieville	91	4	4
Boulder	67	31	3
Escalante	78	11	10
Kanab	88	10	1

SOUTHERN UTAH

IN YOUR OPINION, HOW CAN GOVERNMENT AGENCIES BETTER PROTECT THE ENVIRONMENT?

	Doing Enough	Doing Too Much	Control, Protect, Enforce	Don't Listen to Ecologists	Moderate Policies	Other	Don't Know
Total	23%	17%	15%	3%	3%	5%	34%
Area:							
Boulder	14	36	6	6	6	6	28
Cannonville	12	18	8	2	5	5	50
Escalante	32	23	11	4	5	5	20
Henrieville	24	7	17	7	2	9	35
Kanab	21	14	17	2	2	3	40
Tropic	26	19	15	2	2	10	27

SOUTHERN UTAH

IN YOUR OPINION, HOW CAN GOVERNMENT AGENCIES BETTER ENCOURAGE ECONOMIC GROWTH IN YOUR AREA?

	Doing Too Much	Provide jobs, Industry, Money	Build Power Plants	Develop Resources and Improve Area	Don't Listen to Ecologists	Other	Don't Know
Total	16%	16%	16%	15%	5%	2%	30%
Area:							
Boulder	36	8	8	22	0	3	22
Cannonville	8	25	12	15	0	0	40
Escalante	10	19	16	11	11	4	28
Henrieville	13	30	9	11	2	9	26
Kanab	18	14	18	11	3	1	33
Tropic	15	11	10	37	3	0	23

PAGE, ARIZONA

RESIDENCE:

	Trailer House	Apartment	Private Home
Totals	70%	11%	19%
Sex:			
Male (N=184)	68	14	18
Female (N-190)	72	9	20
Age:			
18-29 (N=111)	69	17	14
30-39 (N=99)	75	7	18
40-55 (N=111)	71	9	20
Over 55 (N-52)	58	12	31
Income:			
$15,000 and under (N=129)	59	19	22
Over $15,000 (N-240)	76	7	18
Occupation:			
Professional and Business	51	12	36
Manual (N-249)	80	11	9

WHILE LIVING IN PAGE WOULD YOU PREFER TO LIVE IN:

	Trailer House	Apartment	Private Home	Don't Know
Total	35%	3%	60%	1%
Sex·				
Male (N=184)	32	4	63	1
Female (N=190)	39	2	57	2
Age:				
18-29 (N=111)	28	4	66	2
30-39 (N=99)	34	2	62	2
40-55 (N=111)	43	0	55	2
Over 55 (N=52)	35	8	58	0
Income:				
Under $15,000 (N=129)	22	5	69	3
Over $15,000 (N=240)	42	2	55	1
Occupation:				
Professional and Business (N=113)	23	2	74	2
Manual (N=249)	43	3	53	2

PAGE, ARIZONA

WOULD YOU SAY YOUR DWELLING IS TOO LARGE, TOO SMALL, OR ABOUT RIGHT?

	Too Large	Too Small	About Right	Don't Know
Total	1%	31%	68%	1%
Sex:				
Male (N=184)	0	35	65	0
Female (N=190)	1	26	72	1
Age:				
18-29 (N=111)	0	38	60	2
30-39 (N=99)	0	41	59	0
40-55 (N=111)	2	17	81	0
Over 55 (N=52)	0	25	75	0
Income:				
Under $15,000 (N=129)	2	36	62	1
Over $15,000 (N-240)	0	28	71	0
Occupation:				
Professional and Business (N=113)	1	25	74	0
Manual (N=249)	0	34	65	1

ARE YOUR YARD FACILITIES TOO LARGE, TOO SMALL, OR ABOUT RIGHT?

	Too Large	Too Small	About Right	Don't Know
Total	0%	36%	64%	0%
Sex:				
Male (N=184)	0	43	57	0
Female (N=190)	0	30	70	0
Age:				
18-29 (N=111)	0	47	53	0
30-39 (N=99)	0	49	52	0
40-55 (N=111)	0	24	76	0
Over 55 (N=52)	0	17	83	0
Income:				
$15,000 and under (N=129)	0	40	61	0
Over $15,000 (N=240)	0	35	65	0
Occupation:				
Professional and Business (N=113)	0	28	72	0
Manual (N=249)	0	41	59	0

PAGE, ARIZONA

HOW LONG HAVE YOU LIVED IN PAGE?

	Less than 2	2 to 10	More than 10
Total	53%	36%	10%
Sex:			
Male (N=184)	56	34	10
Female (N=189)	51	39	11
Age:			
18-29 (N=111)	69	23	7
30-39 (N=99)	50	44	5
40-55 (N=110)	50	36	14
Over 55 (N=52)	33	46	21
Income:			
$15,000 and under (N=129)	50	32	19
Over $15,000 (N=239)	56	38	6
Occupation:			
Professional and Business (N=113)	49	33	19
Manual (N=248)	57	38	5

ARE YOU PLANNING TO LEAVE PAGE IN THE NEAR FUTURE?

	Yes	No	Don't Know
Total	42%	49%	9%
Sex:			
Male (N=184)	40	51	9
Female (N=190)	43	47	10
Age:			
18-29 (N=111)	49	43	8
30-39 (N=99)	37	54	8
40-55 (N=111)	42	46	12
Over 55 (N=52)	35	56	10
Income:			
$15,000 and under (N=129)	36	58	5
Over $15,000 (N=240)	45	44	11
Occupation:			
Professional and Business (N=113)	31	63	6
Manual (N=249)	47	42	11

PAGE, ARIZONA

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Total	55%	21%	24%
Sex:			
Male (N=183)	58	20	22
Female (N=190)	52	23	25
Age:			
18-29 (N=110)	60	24	16
30-39 (N=99)	52	27	20
40-55 (N=111)	54	14	32
Over 55 (N=52)	52	21	27
Income:			
$15,000 and under (N=129)	54	27	19
Over $15,000 (N=239)	56	18	27
Occupation:			
Professional and Business (N=113)	54	26	20
Manual (N=248)	56	18	27

DO YOU FAVOR A SLIGHT OR SUBSTANTIAL INCREASE?

	Slight	Substantial
Total	29%	24%
Sex:		
Male (N=183)	30	26
Female (N=190)	27	22
Age:		
18-29 (N=110)	32	28
30-39 (N=99)	29	22
40-55 (N=111)	25	25
Over 55 (N=52)	27	13
Income:		
$15,000 and under (N=129)	26	27
Over $15,000 (N=239)	30	22
Occupation:		
Professional and Business (N=113)	26	26
Manual (N=248)	30	23

PAGE, ARIZONA

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SLIGHTLY?

	Favor	Oppose	Don't Know
Total	36%	36%	28%
Sex:			
Male (N=184)	39	35	26
Female (N=190)	34	36	30
Age:			
18-29 (N=111)	35	46	19
30-39 (N=99)	39	37	23
40-55 (N=111)	40	22	39
Over 55 (N=52)	27	39	35
Income:			
$15,000 and under (N=129)	30	50	21
Over $15,000	40	28	32
Occupation:			
Professional and Business (N=113)	40	41	20
Manual (N=249)	36	31	32

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SUBSTANTIALLY?

	Favor	Oppose	Don't Know
Total	15%	55%	30%
Sex:			
Male (N=184)	17	54	29
Female (N=190)	13	56	32
Age:			
18-29 (N=111)	12	67	22
30-39 (N=99)	14	59	27
40-55 (N=111)	18	43	39
Over 55 (N=52)	15	50	35
Income:			
$15,000 and under (N=129)	14	64	22
Over $15,000 (N=240)	15	50	34
Occupation:			
Professional and Business (N=113)	13	63	24
Manual (N=249)	16	51	33

DO YOU APPROVE OR DISAPPROVE OF OUTSIDE INTERESTS INVESTING MONEY IN THIS COMMUNITY?

	Approve	Disapprove	Don't Know
Total	81%	8%	11%
Sex:			
Male (N=184)	83	8	10
Female (N=190)	80	8	12
Age:			
18-29 (N=111)	81	8	11
30-39 (N-99)	80	9	11
40-55 (N=111)	83	8	9
Over 55 (N=52)	81	4	15
Income:			
$15,000 and under (N=129)	78	5	18
Over $15,000 (N=240)	83	9	8
Occupation:			
Professional and Business (N=113)	91	5	4
Manual (N=249)	78	9	13

DO YOU FAVOR OR OPPOSE THE RECRUITMENT OF MINORITY GROUPS (SUCH AS INDIANS) TO WORK IN LOCAL POWER PLANTS?

	Favor	Oppose	Don't Know
Total	85%	12%	4%
Sex:			
Male (N=184)	84	14	2
Female (N=190)	85	10	5
Age:			
18-29 (N=111)	86	12	2
30-39 (N=99)	83	12	5
40-55 (N=111)	85	11	4
Over 55 (N=52)	85	12	4
Income:			
$1,5000 and under (N=129)	81	12	6
Over $15,000 (N=240)	87	11	2
Occupation:			
Professional and Business (N=113)	88	9	4
Manual (N=249)	84	12	4

PAGE, ARIZONA

DO YOU ANTICIPATE CHANGING YOUR EMPLOYMENT IF THIS COMMUNITY GROWS SUBSTANTIALLY?

	Yes	No	Don't Know
Total	8%	91%	1%
Sex:			
Male (N=184)	9	90	1
Female (N=190)	7	92	1
Age:			
18-29 (N=111)	12	86	3
30-39 (N=99)	9	91	0
40-55 (N=111)	6	94	0
Over 55 (N=52)	4	96	0
Income:			
$15,000 and under (N=129)	9	89	2
Over $15,000 (N=240)	8	92	0
Occupation:			
Professional and Business (N=113)	11	89	0
Manual (N=249)	8	91	1

WHICH DO YOU BELIEVE IS MOST IMPORTANT IN THIS AREA?

	Economic Development	Environmental Conservation	Both	Don't Know
Total	40%	25%	32%	3%
Sex:				
Male (N=184)	46	25	29	1
Female (N=190)	34	25	35	6
Age:				
18-29 (N=111)	27	44	23	4
30-39 (N=99)	39	25	32	3
40-55 (N=111)	46	12	40	3
Over 55 (N=52)	54	12	31	4
Income:				
$15,000 and under (N=129)	32	30	30	8
Over $15,000 (N=240)	44	22	33	1
Occupation:				
Professional and Business (N=113)	35	24	38	3
Manual (N=249)	42	25	29	4

APPENDIX IV - 1

Statutes, Regulations and Contracts

APPENDIX IV-1

Statutes, Regulations and Contracts

Federal

(CFR - Code of Federal Regulations; USC - United States Code; PL - Public Law).

National Environmental Policy Act of 1969 (83 Stat. 852, USC 431 et seq.).

Contract for Water Service from Lake Powell (Contract No. 14-06-400-5139). Federal Coal Leases held by Resources Co. et al - Bureau of Reclamation.

Fossil Fuel burning installations, (40 CFR, Part 60).

Federal ambient air quality standards (42 CFR, Part 410).

Clean air, Clean Air Act of 1970, as amended.

Prevention of significant air quality deterioration, Environmental Protection Agency (Federal Register, Vol. 38, No. 235, December 5, 1974).

Steam Electric Power Generating Point Source Category, Effluent Guidelines and Standards, Environmental Protection Agency (Federal Register, Vol. 39, No. 196, October 8, 1974).

Control of radioactive air pollution from coal burning, Atomic Energy Act of 1954 (68 Stat. 919; 43 USC, Sec. 2011, et seq.; 10 CFR, Part 20).

Objects affecting navigable air space (smokestacks, buildings), Federal Aviation Act of 1958 (PL 85-726, August 23, 1958; 72 Stat. 749, 797; 49 USC 1348, 1501; 14 CFR, Part 77).

Highway development and construction (PL 85-767, August 27, 1968; 72 Stat. 885; Title 23 USC Chapter 1, Section 109; 23 CFR 1.3, .4).

Interstate and Defense Highway System, Federal-Aid Highways (23 USC, Chapter 1, Section 109).

Federal Environmental Pesticide Control Act of 1972 (PL 92-516; 7 USC 136).

Requirements relating to preservation of the quality of interstate water, Federal Water Pollution Control Act (requirements under authority of Utah Code Section 26-15-4 and 5, Section 73-14-1 to 13 Utah Code, annotated 1953, as amended).

Act to amend the Federal Water Pollution Control Act (PL 92-500, October 18, 1972).

The Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 USC 661 et seq., in Section 662).

The Endangered Species Act of 1973 (PL 93-205).

Bald Eagle Protection Act (16 USC 668-668d).

Executive Order 11593 of 1971 (36 CFR 8921).

Archaeological Preservation Act of 1974 (88 Stat. 174, PL 93-291, 16 USC 469a-1, 2).

National Historic Preservation Act of 1966.

Federal Antiquities Act of 1906 (24 Stat. 225, 16 USC 431 et seq.).

Historic Sites Act of 1935 (49 Stat. 666, 16 USC 461 et seq.).

National Historic Preservation Act of 1966 (80 Stat. 915, 16 USC 470 et seq.).

Occupational Safety and Health Act of 1970, approved December 29, 1970 (84 Stat. 1590; 5 USC 7902; 29 USC 651-678; Executive Order 11612, July 26, 1971; 36 CFR 13891).

Solid Waste Disposal Act, as amended (42 USC 3251).

Noise Control Act of 1972 (42 USC 4091).

Executive Order No. 11752, December 17, 1973 (38 CFR 32793).

Communication stations, Act of June 19, 1934, as amended (48 Stat. 1082; 47 USC 303; 47 CFR 1.70).

Water plants, pipelines, etc., Act of February 15, 1901 (31 Stat. 790; 43 USC 959; 43 CFR, Sub-part 2873, as applied to National Park Service in 43 CFR 2801.1-7).

Safety standards for underground coal mines, Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 745; 30 USC 811; 30 CFR, Part 75).

Safety standards for open pit metal and nonmetallic mines (limestone), Sec. 6 of the Federal Metal and Nonmetalic Mine Safety Act of September 16, 1966 (PL 89-577; 80 Stat. 774; 30 USC 725; 30 CFR, Part 55).

Regulations governing Geological Survey authority concerning coal-mining operations, (30 CFR, Part 211).

Coal Leases Act of February 25, 1920 (41 Stat. 437; 30 USC 181 et seq., as amended and supplemented; Secs. 2-8, 41 Stat. 438 et seq.; 30 USC 201-208, as amended; 43 CFR, Parts 23 and 3500; Secretary of the Interior Order No. 2948, October 6, 1972).

Protection and conservation of nonmineral resources during discovery, development, surface mining, and on-site processing of minerals under permits, leases, or contracts issued under the Mineral Leasing Act of February 25, 1920, as amended (30 USC 181-287) for new leases and readjustments of lease terms for existing leases; and under the Materials Act of July 31, 1947, as amended (30 USC 601-604), (Department of the Interior regulations; 43 CFR, Part 23).

Tramroads for mine access, coal haul road, conveyor belt, etc., Act of January 21, 1895 (28 Stat. 635; 43 USC 956; 43 CFR, Part 2810).

Roads and highways (23 USC 107, or RS 2477; 43 USC 932; 43 CFR, Part 2820).

Power transmission lines, Act of March 4, 1911 (36 Stat. 1253; 43 USC 961; 43 CFR, Part 2850).

Recreation and public purposes lease for sanitary land fill area, recreation development, educational purposes, etc., Act of June 14, 1926 (44 Stat. 741; 43 USC 869-4; 43 CFR, Sub-parts 2740 and 2912).

Free use of timber (43 CFR, Part 5511); minerals (43 CFR, Part 3621); petrified wood (43 CFR, Part 3622).

Motor vehicles on national resource lands (43 CFR, Part 6251).

Visitor management on national resource lands (43 CFR, Part 6260).

Trespass on national resource lands (43 CFR, Part 9230).

Special land use permits for purposes not specifically provided for by existing law (Revised statute 446, 453 and 22478, as amended; 43 USC 1, 2, 1201; Act of July 14, 1960; 70 Stat. 506; 43 USC 1361-1364; 43 CFR, Part 2920).

U.S. Forest Service (36 CFR Part 252, Federal Register, Vol. 39, page 31317, August 28, 1974).

U.S. Forest Service (36 CFR Part 251.1).

U.S. Forest Service (30 Stat. 34, as amended and supplemented, 16 USC 460 471-594, 616, 694 and 1131-1135; 33 USC 701; 7 USC 1010-1013a; 36 CFR 200.3 et seq.).

National Park Service (36 CFR, Part 4.11; 36 CFR, Part 800.10).

State of Utah

Utah State Division of Lands

Mineral Leases (Utah Code annotated, 1953, as amended 65-1-18).

Permits and easements on State lands for power transmission lines, roads, water pipelines, etc. (Utah Code Annotated, 1953, as amended, 65-2-1).

Utah State Engineer (Utah Code annotated, 1953, as amended).

Utah State Division of Health, Bureau of Environmental Health

Water Quality Section, Control of water pollution (Utah Code annotated, 1953, as amended, Chapter 73-14, 73-14-5 to 73-14-13).

General Sanitation Section, Control of solid waste (Utah Code annotated, 1953, as amended, Title 26.

Department of Social Services (Code of Air Conservation Regulations, January 24, 1972, ibid).

Executive Order No. 11752

Title 10, Utah Code, Chapter II

Title 10, Utah Code, Chapter 7, Section 14

Title 26, Utah Code, Chapter 14, Section 4

Title 10, Utah Code, Chapter 15

Title 10, Utah Code, Chapter 9

Utah Antiquities Act 63-8-21 through 63-11-31 Utah Code annotated, 1953.

APPENDIX IV-2

Statutory and Administrative Requirements

APPENDIX IV-2

Statutory and Administrative Requirements

Transmission system impact area

The participants would comply with all statutory and administrative requirements of the United States Government and the State of Utah, Arizona, Nevada and California including, but not limited to, the following:

Clean Air Act of 1970 as amended.

Federal and State ambient air quality standards established for Arizona, California, Nevada, Utah.

Air quality standards of Occupational Safety and Health Administration (OSHA), Arizona, California, Nevada, and Utah apply to the environment in and around working areas for the transmission line.

Federal Water Pollution Control Act of 1972 as amended, and the Arizona, California, Nevada and Utah codes on water pollution control.

The Noise Control Act of 1972 and State counterparts.

The National Environmental Policy Act of 1969.

The Endangered Species Act of 1973.

The Bald Eagle Act as amended 1966.

The Migratory Bird Treaty Act as amended.

The Fish and Wildlife Coordination Act as amended.

Interstate and Defense Highway System (Title 23, United States Code).

Arizona, California, Nevada and Utah regulations and codes pertaining to wildlife species in these states.

The Federal Antiquities Act of 1906.

The Archaeological Preservation Act of 1974.

Historic Sites Act of 1935.

National Historic Preservation Act of 1966.

Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment."

Archaeological Preservation Act of 1974; amends Reservoir Salvage Act of 1960.

Arizona Archaeological, Paleontological and Historical Preservation Act.

Code of Federal Regulations, Preservation of American Antiquities.

California Penal Code, Antiquities; Nevada, Antiquities Act; Utah Antiquities Act; and California, Public Resource Code.

Code of Federal Regulations, Title 43.

Code of Federal Regulations, Title 36.

APPENDIX VIII-1

Alternative Methods for Making National Resource Land Available for Kaiparowits Plantsites and Townsite

APPENDIX VIII-1

ALTERNATIVE METHODS FOR MAKING NRL AVAILABLE

FOR

KAIPAROWITS PLANTSITES AND TOWNSITE

September 10, 1975

Issue: What law will provide the most appropriate vehicle to effect transfer of title to national resource lands for the proposed Kaiparowits Power Project plantsite and townsite?

Alternatives:

1. Public Sales (43 CFR 2710)
2. Small Tracts (43 CFR 2730)
3. Recreation and Public Purposes (43 CFR 2740)
4. Proposed Federal Land Policy and Management Act of 1975
5. Special Legislation
6. Right-of-Way (43 CFR 2850)
7. Townsite (43 U.S.C. 711)
8. Private Exchange (43 CFR 2200, 2220)
9. State Exchange (43 CFR 2200, 2210)
10. Indemnity Lieu State Selection (43 CFR 2621)
11. Quantity Grant State Selection (43 CFR 2622)

Background/Analysis: See memo dated July 17, 1975 to Director (321 - 322) from State Director, Utah, subject: Plan for Transfer of NRL to State of Utah for Proposed Townsite for Kaiparowits Power Project -- copy attached.

Discussion of Alternatives (Advantages and Disadvantages):

1. Public Sale --

   Advantages: None.

   Disadvantages: "Isolated tracts of up to 1,520 acres in size which could be utilized for community expansion purposes can be offered for sale, but this does not apply to the Kaiparowits situation. There is no assurance that land sold would be developed and utilized for the purposes intended. The high bidder or contiguous owner meeting the high bid would exercise all control on future use of the tract, subject to local land use controls. In veiw of this, and because R.S. 2455 criteria apply only to isolated or rough and mountainous tracts, it does not offer a practical or efficient means of title transfer for community development." 1/

2. Small Tracts --

   Advantages: None.

   Disadvantages: "Suitable tracts in or near areas requiring land for urban expansion could be classified for small tract disposal.

However, there is no assurance that land would be utilized for community expansion. This authority would place the entire burden on BLM for classification, survey, disposal of lots to applicants, and compliance. Use of this act for new towns or community expansion would put BLM, in fact, in the "subdivision" business. As a matter of policy, BLM has declined to become involved in this role of utilizing the Small Tract Act in the recent past. Development of public facilities (roads, sewers, etc.) has been a continuing problem in small tract areas." 1/ Small tract programs have not been successful in other areas.

3. Recreation and Public Purposes --

   Advantages: NRL could be made available at low cost to State or local governmental agencies for such public purposes as parks, schools, and sanitary landfills.

   Disadvantages: "Lands transferred under this authority would have to be planned and utilized exclusively for recreation or public purposes. Whether any residential use can be considered a public purpose is questionable. Both policy and legal questions may be involved. In view of this, the R&PP authority has limited availability for community development." 1/ It would not apply to plantsites.

4. Proposed Federal Land Policy and Management Act of 1975 --

   Advantages: "The Public Land Sale Act (P.L. 88-608) of September 19, 1964, authorized the Secretary of the Interior to sell lands which were required for the orderly growth and development of a community or lands that are chiefly valuable for residential, commercial, agricultural, industrial, or public use or development. Since this act expired on December 23, 1970, we do not have adequate legal authority designed to meet this type of need. Enactment of BLM's organic legislation would provide modern disposal authority. The Administration's draft legislation includes authority for disposal of national resource lands for uses which cannot be prudently achieved on other lands, and which outweigh public objectives and values which would be served by maintaining the land in Federal ownership." 1/

   Disadvantages: Similar bills have been considered by Congress for several years but have not been enacted into law.

5. Special Legislation --

   Advantages: "Also, there is always the possibility of special legislation to allow disposal of national resource lands to a specific community." 1/ This would have the advantage of addressing itself to a specific site for a specific purpose.

   Disadvantages: "This, however, is a slow process. In the past, Congress has enacted legislation only when a community has presented comprehensive land use plans." 1/

6. Right-of-Way --

Advantages: The act of February 15, 1901 authorized the Secretary to permit the use of rights-of-way for electrical plants, etc., which might provide authority for the plantsites, but not the townsite. Would not involve title transfer, so may be less complicated than other methods. Provides more positive control by Federal Government on use of the NRL by stipulations in the right-of-way grant.

Disadvantages: This is probably not an acceptable alternative to the power companies; they have indicated they cannot obtain financing if they do not have fee title to the land.

7. Townsites --

Advantages: "Public lands have been reserved for townsite purposes by the President and the Secretary of the Interior from time-to-time. Lands with special location or other attributes were withheld from other occupancy or disposition pending their planning, survey, appraisal, and public sale." 1/

Disadvantages: We believe these laws are either inapplicable or improper for use in this situation for a number of reasons. These include:

(1) Trustee Townsites as covered by 43 CFR 2763 are inapplicable to Kaiparowits since "prospective townsites cannot be entered" (2763.2) and, of course, there is no town in existence at the Kaiparowits site.

(2) Townsites authorized by section 2382 of the Revised Statutes, as amended, and sections 2383, 2384, and 2386 of the Revised Statutes are also only applicable where prior occupancy is involved. Since pre-emptive settlement is no longer authorized, these statutes are also not applicable to Kaiparowits.

(3) Townsites authorized by section 2380 of the Revised Statutes (43 U.S.C. 711) could be used in the Kaiparowits situation. However, this manner of making the townsite lands available is constrained by numerous factors:

(a) The lands would have to be surveyed into lots, blocks, streets, alleys, etc;

(b) Survey would have to be done to BLM Cadastral standards with considerable delay to the whole project;

(c) All lots would have to be appraised at fair market value and sold at public auction;

(d) BLM would have to prepare individual patents for all the lots to be sold and this could cause delay;

(e) Local government would have to assume responsibility for putting in all sewers, paving, alley-ways, guttering, etc., since Interior is clearly not in the land subdivision business;

(f) Interior, if it did the development and lay-out of the town, would be under intense pressure to produce a "showplace" community rather than one adequate to meet the needs of the project and area residents;

(g) Participation by Interior would certainly be construed as favorable treatment of the proponent;

(h) Townsite development is more properly a function of local rather than Federal Government;

The townsite laws do not apply at all to acquisition of land for the plantsite, so some other method would have to be used for that.

E. G. Bywater was the Bureau of Reclamation official responsible for development of the town of Page, Airzona. It was developed solely by the Bureau of Reclamation with no tax revenue by the State or County. He said it was more than two years from inception before any dirt was moved and anything was put on the ground. First improvements were trailers and temporary commercial facilities. He estimated a development cost of $10,000,000 for Kaiparowits townsite. He charged a "municipal service charge" in lieu of property taxes, but didn't get any income tax, gas tax, sales tax, etc., revenue from the State or County, so the Bureau of Reclammation had to supplement administrative costs with special congressional appropriations. They didn't get any State or County help with zoning, yet had to comply with State and County laws and ordinances. Bureau of Reclammation had to furnish all municipal services such as police, fire, sewer, water, roads, parks, schools, etc. He raised the question on Kaiparowits townsite as to who would accept and enforce these administrative responsibilities, and where would the financial base come from to develop the townsite.

8. Private Exchange --

Advantages: "There may be situations where use of a land exchange could be looked upon with favor if, as a result of the exchange, BLM would acquire private lands which would benefit the public interest as required by Section 8 of the Taylor Grazing Act." 1/

Disadvantages: "Experience has shown that use of exchange authorities for this purpose is generally frustrating, time-consuming, and combersome to say the least. Since the exchange must be based on benefit to Federal interests or programs, its application is severely limited for community development purposes." 1/ We have no idea how long it might take the power companies to put together an exchange package by acquiring title to or options to purchase enough fee land to offer as base for the NRL they propose to acquire from BLM.

9. State Exchange --

Advantages: The State of Utah has indicated an interest in exchanging State land for the plant and townsites. The State has plenty of scattered school sections they would like to trade to BLM.

Disadvantages: Federal law (The Jones Act of January 25, 1927 (44 Stat. 1026; 43 U.S.C. 870)) prohibits the State from disposing of mineral rights in their base lands on such exchanges. Also by State law, the State must offer lands they acquire by exchange for public auction, unless the base lands used in the exchange have previously been offered for sale at public auction but did not sell.

10. Indemnity Lieu State Selection --

Advantages: "The State may select and acquire land in satisfaction of indemnity entitlement. The land could then be transferred to local public or private entities for development of plantsites or new towns or expansion of existing settlements. In this case, the State or local Government would assume the basic responsibility for evaluation of community expansion plans, adequacy of planning and land use controls, and determination of the terms and conditions of sale of the land to the ultimate beneficiaries." 1/ The State has outstanding indemnity entitlement of 225,360.59 acres for which they have pending applications for 197,643.25 acres, leaving an unobligated entitlement of 27,717.34 acres.

Disadvantages: The principal problem is the value estimate of the selected and base lands required by Departmental policy, and the contingent value disparity question primarily because of mineral values. There is also some problem here with the State's disposal of these lands as public auction is required. The Division of State Lands seem reluctant to use their base for this purpose.

11. Quantity Grant State Selection --

Advantages: We feel that this is by far the best method, the one that would offer the least possibility of problems or complications. Under this provision, the State may select and acquire land in satisfaction of quantity grant entitlement. The State could then transfer title to the land by sale negotiated directly with the power companies or their representatives for development of plantsites or townsites. The State or local government would assume the basic responsibility for evaluation of community development plans, adequacy of planning and land use controls, and determination of the terms and conditions of sale of the land to the ultimate beneficiaries. The State has outstanding quantity grant entitlement of 17,633.00 acres for which they have pending applications for 2,181.60 acres, leaving an unobligated entitlement of 15,451.40 acres. No value estimate is required and there will be no consideration of value disparity.

Disadvantages: The principal problem is that the University of Utah is the only State agency who controls enough quantity grant base entitlement to cover the acreage required for the plantsite and townsite, and they are reportedly reluctant to use their base for this purpose.

Ed. D. Cox

1/ Excerpt from Information Memorandum No. 75-160, dated 8/25/75, Subject: Community Expansion Needs Associated with Energy Development.

APPENDIX VIII-2

Letter from California Air Resources Board - Possibility of Siting Coal-fired Power Plants in Southern California

STATE OF CALIFORNIA
EDMUND G. BROWN JR., Governor

AIR RESOURCES BOARD
1709 - 11th STREET
SACRAMENTO 95814

January 5, 1976

Paul L. Howard, State Director
U.S. Department of the Interior
Bureau of Land Management
Utah State Office
Post Office Box 11505
Salt Lake City, Utah 84147

Dear Mr. Howard:

This is in response to your letter to the Air Resources Board regarding the possibility of locating coal-fired power plants in Southern California.

The California Air Resources Board is very cognizant of the difficulties surrounding the location of suitable sites in the western states for large coal burning power plants, and of the impact Southern California has on the growing need for such facilities. We are keenly interested in the successful resolutions of these problems and are eager to contribute in any way to that end.

Location of the facilities in California would be virtually impossible. Even if the long transport of coal from the mines to the west coast could be justified, the severe air pollution problems in Southern California would eliminate all coastal sites. The adjacent inland areas are all critically short of water which would have to be transported long distances. Those areas of the state with more abundant water are mostly prime agricultural land or recreation areas, neither of which could readily accommodate a major coal burning power plant.

The probability of a coal-fired generating station meeting the stringent air quality standards of the California air pollution control districts is low, even with the best emission control technology. Existing emission limitations of the districts within the South Coast Air Basin which apply to new sources are listed in Table I.

In addition, the Air Resources Board has recently adopted a new source review program that must be adopted by the local districts. This new program, based on denial of permits to construct if a source will interfere with attainment of federal air quality standards, will lower the probability of constructing coal-fired plants in California even further. It is anticipated that all the districts in California will adopt the new Air Resources Board rule or a similar rule within six months. A copy of the requirements plus a suggested rule is enclosed. Those basins in Southern California (South Coast, Southeast Desert and San Diego) which exceeded the ambient air quality standards in 1973 are included in Table 2. Pollutant concentrations during 1974 and 1975 have not changed significantly. Thus, the new source review rule may prevent the approval of major sources in these areas.

Table 3 compares the projected emissions for the Kaiparowits generating station with the most stringent emission rules for Southern California. Obviously a plant such as Kaiparowits would violate these standards. The Southeast Desert Air Basin portion of Riverside County is the only location in Southern California where a power plant might be compatible with the local air pollution regulations. The applicable emission limitations for that portion of Riverside County possibly could be met with existing technology for coal fired power plants. This could be determined only after detailed evaluation of the proposal. The area, however, lacks the water necessary for a power plant of this size.

Sincerely,

George J. Taylor
Assistant Executive Officer
(916) 322-2894

Enclosure

TABLE 1

New Source Rules and Regulations

	Prohibitions		
Air Pollution Control District	Pollutant	Rule Number	Limitations
South Coast Air Basin			
(1) Southern California			
(a) Metropolitan Zone (L.A.)	Particulate Matter	68.1	0.3 gr/scf @ 12% CO_2
		54	1.0 - 30.0 #/hr for Process Weight 250-1,000,000 #/hr
		67	$\leq$ 10 lbs./hr.
(b) Eastern Zone (Orange)		68.1	0.1 gr/scf @ 12% CO_2
		54	same as Metropolitan Zone Process Weight
		67	$\leq$ 10 lb./hr
(c) Riverside County Zone		72.2	0.1 gr/scf @ 12% CO_2
		54	0.5 lbs./ton process weight
		72	$\leq$ 10 lb./hr
(d) San Bernardino County Zone		53A	0.1 gr/scf @ 12% CO_2
		54A	same as Metropolitan Zone Process Weight
		67	$\leq$ 10 lbs./hr.
(2) Ventura County		57	0.1 gr/scf @ 12% CO_2
		53	same as Metropolitan Zone Process Weight
		60	$\leq$ 10 lbs./hr.
(3) Santa Barbara County		18A	0.1 gr./scf @ 12% CO_2
		21A	same as Metropolitan Zone Process Weight
		39	$\leq$ 10 lbs./hr.

Air Pollution Control District	Pollutant	Rule Number	Limitations
(1) Southern California			
(a) Metropolitan Zone	SO_2	53	0.2%, by volume
		67	≤ 200 lbs./hr.
(b) Eastern Zone		53	500 ppm, by volume
		67	≤ 200 lbs./hr.
(c) Riverside County Zone		53	0.05%, by volume
		72	≤ 200 lbs./hr.
(d) San Bernardino County Zone		53A	500 ppm, by volume
		67	≤ 200 lbs./hr.
(2) Ventura County		54	300 ppm, by volume
		60	≤ 200 lbs./hr.
(3) Santa Barbara County	SO_2	19	0.2%, by volume
		39	≤ 200 lbs/hr.
(1) Southern California			
(a) Metropolitan Zone	NO_2	67	≤ 140 lbs./hr.
		68	125/225 ppm for gaseous/liquid, solid fuels
(b) Eastern		67	Same limits as for Metropolitan Zone
		68	
(c) Riverside County Zone		72	Same limits as for Metropolitan Zone
		72.1	
(d) San Bernardino County Zone		67	Same limits as for Metropolitan Zone
		68	

Air Pollution Control District	Pollutant	Rule Number	Limitations
(2) Ventura County		59	125/225 ppm, with limit of 20 tons per day
		60	$\leq$ 140 lbs./hr.
(3) Santa Barbara County		39	Same limits as for Metropolitan Zone
		39.1	
San Diego Air Basin			
San Diego County	Particulate Matter	53	0.1 gr/scf @ 12% CO_2
		54	.24 - 40 #/hr. for Process Weight 50-60,000 #/hr.
	SO_2	53	0.05%, by volume
	NO_2	68	.125/225 ppm for gaseous/liquid, solid fuel
Southeast Desert Air Basin			
(1) Kern County	Particulate Matter	407.2	0.1 gr/scf @ 12% CO_2
		409	Meet EPA Standards of Performance
(2) Southern California			
(a) Metropolitan		68.1	0.3 gr/scf @ 12% CO_2
		54	1.0 - 30.0#/hr. for Process Weight 250 - 1,000,000 #/hr.
		67	$\leq$ 10 lbs./hr.
(b) Riverside County Zone		72.2	0.1 gr/scf @ 12% CO_2
		54	0.5 lbs./ton process weight per hour

Air Pollution Control District	Pollutant	Rule Number	Limitations
(d) San Bernardino Zone	Particulate Matter	53A	0.1 gr./scf @ 12% CO_2
		54A	same as Metropolitan Zone Rule 54
		67	≤ 10 lbs./hr.
(3) Imperial County		116	0.3 gr/scf @ 12% CO_2
		121	.24-40 #/hr. for Process Weight 50 - 60000 #/hr.
		131	≤ 10 lbs./hr.
(1) Kern County	SO_2	407	0.2% by volume
		409	Meet EPA Standards of Performance
(2) Southern California			
(a) Metropolitan Zone		53	0.2%, by volume
		67	200 lbs./hr.
(c) Riverside County Zone		53	0.15%, by volume
(d) San Bernardino County Zone		53A	500 ppm, by volume
		67	≤ 200 lbs./hr.
(3) Imperial		116	0.2%, by volume
		131	≤ 200 lbs./hr.
	NO_x		
(1) Kern		409	Meet EPA Standards of Performance
(2) Southern California			
(a) Metropolitan		67	≤ 140 lbs./hr.
		68	125/225 ppm for gaseas/liquid, solid fuels

Air Pollution Control District	Pollutant	Rule Number	Limitations
(c) Riverside County Zone		72.1	Same as Metropolitan Zone Rule 68
(d) San Bernardino County Zone		67	$\leq$ 140 lbs./hr.
		68	Same as Metropolitan Zone Rule 68
(3) Imperial		131	$\leq$ 140 lbs./hr.

MAXIMUM MEASURED POLLUTANT CONCENTRATIONS FOR EACH AIR BASIN IN 1979

POLLUTANT	AVERAGING TIME	STANDARDS			AIR BASIN										
		STATE PPM	FEDERAL PRIMARY PPM	FEDERAL SECONDARY PPM	NORTH COAST	SF BAY AREA	NORTH CENTRAL COAST	SOUTH CENTRAL COAST	SOUTH COAST	SAN DIEGO	NE PLATEAU	SACTO. VALLEY	SAN JOAQUIN VALLEY	GREAT BASIN VALLEYS	SE DESERT
Oxidant	1 Hr	0.10	0.08	--	0.07	0.30	0.16	0.13	0.63	0.32	a	0.24	0.26	a	0.31
Carbon Monoxide	1 Hr	40.0	35.0	--	a	23	13	16	43	24	a	16	25	a	22
	8 Hr	--	9.0	--	a	18	< 10	11	31	16	a	10	13	a	< 10
	12 Hr	10.0	--	--	a	14	< 10	10	29	13	a	< 10	10	a	< 10
Nitrogen Dioxide	1 hr	0.25	--	--	0.10	0.26	0.14	0.11	0.58	0.32	a	0.22	0.16	a	0.17
	am	--	0.05	--	0.017	0.048	0.023	0.022	0.074	0.029	a	0.029	0.029	a	0.04
Sulfur Dioxide	1 Hr	0.5	--	--	a	0.26	a	a	0.28	0.07	a	a	0.16	a	a
	24 Hr	0.04	0.14	--	a	0.06	a	a	0.10	0.02	a	a	0.04	a	a
	am	--	0.03	--	a	0.006	a	a	0.032	0.005	a	a	0.011	a	a
Particulate Matter	24 Hr	100 µg/m^3	260 µg/m^3	150 µg/m^3	343	225	563	253	1306	253	661	443	601	449	1173
	agm	60 µg/m^3	75 µg/m^3	60 µg/m^3	125	68	83	84	162	104	74	88	139	102	236
Lead	30 Day	1.5 µg/m^3	--	--	0.76	2.30	0.82	1.11	3.40	3.45	0.39	1.51	3.46	0.85	0.85

a) Air monitoring data are not available for this pollutant

am: Annual arithmetic mean
agm: Annual geometric mean

TABLE 3

COMPARISON OF COAL FIRED POWER PLANT EMISSIONS WITH ALLOWABLE EMISSIONS

Estimated Project Emissions (as presented in EIS)	Pollutant	Allowable Emissions* lbs/hr	Allowable Emissions* tons/day
34.3 tons/day	SO_2	200	2.4
250.0 tons/day	NOx	140	1.68
12.2 tons/day	PM	10	0.12

* Allowable emissions based on most stringent regulations for new power plants in Southern California.

APPENDIX IX-1

Bureau of Reclamation Letter: Kaiparowits Public Hearing Comments Concerning Water Availability of Lake Powell

March 3, 1849

United States Department of the Interior
BUREAU OF RECLAMATION
UPPER COLORADO REGIONAL OFFICE
P.O. BOX 11568
SALT LAKE CITY, UTAH 84111

IN REPLY REFER TO: 460
651.-

NOV 14 '75

Memorandum

To: District Manager, Bureau of Land Management, Utah State Office, P.O. Box 11505, Salt Lake City, Utah 84147

From: Asst. to the Regional Director, Salt Lake City, Utah

Subject: Kaiparowits Public Hearing Comments Concerning Water Availability of Lake Powell (refer to your letter of September 29, 1975)

In response to your letter of September 29, 1975, referred to above, we have reviewed the statement by Mr. Robert L. Coshland for the record of the public hearing in Phoenix on September 17, 1975, on the draft Environmental Statement for the Kaiparowits Powerplant. Mr. Coshland contends that the Environmental Statement fails to reveal realistically the deficient water resources in the Colorado River Basin and in particular that which would be available for storage in Lake Powell and consumption by the Kaiparowits Powerplant. Mr. Coshland further contends that water from Lake Powell for this purpose would be unavailable after about year 2005. Mr. Coshland bases these contentions on the following assumptions and conditions:

1. That the virgin flow data at Lee Ferry, Arizona, are reliable only for the years subsequent to 1922 when the first gage was installed on the Colorado River at this point.
2. The Central Arizona Project will begin diverting water and, in fact, take its full diversions of water in 1985.
3. That the Animas La-Plata, Dallas Creek, Dolores, San Miguel and West Divide Participant Projects will be completed concurrently with the Central Arizona Project and would take a full diversion in the year 1985.
4. That Lake Powell in its normal operation to provide among other things, for the delivery of the water required under Article III C and III D of the Colorado River Compact would have 3.45 million acre-feet of space at the end of September of each year.

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5. That the allowable minimum delivery at Lee Ferry would be 8.25 million acre-feet each year.

Based on these and other assumptions, Mr. Coshland has demonstrated that, if the Upper Basin use reaches 6.1 million acre-feet of consumptive use by the year 2000, the reservoirs of the Upper Colorado River System will be slowly dried up by the release of 8 1/4 million to the lower basin. We agree that under those conditions this would likely happen.

It has been the Bureau of Reclamation's position in certifying available water to the water service contracts out of Navajo Reservoir that the limit of Upper Basin use would be about 5.8 million acre-feet during a period of runoff similar to that which occurred between 1906 and 1974. In order to avoid a critical compact interpretation, this limit of Upper Basin use has been based on the assumption that the Upper Basin would be obligated to deliver 75 million acre-feet of water every 10 years at Lee Ferry, plus 750,000 acre-feet annually toward the Mexican Treaty deliveries. In preparing this estimate of limit of use, the Bureau has recognized that in years or periods of years of low flow, the water actually physically available to be diverted for irrigation use is less than normal at the point of diversion. Therefore, for periods such as the 1931 to 1974 used by Mr. Coshland, the average use projected by the Bureau studies in the Upper Basin would be about 5.4 million acre-feet or about 93 percent of normal. Within this 5.4 million acre-feet, water would be available for the Kaiparowits Project. Water availability studies for the Upper Colorado River Basin that have been prepared by the Bureau recognize depletions of 102,000 acre-feet by the Kaiparowits Powerplant in 1990 as provided for in the water service contract for the project. We assume that Mr. Coshland is also aware of the fact that the Kaiparowits Powerplant water service contract provides for a reduction in the quantity of water available for delivery to the powerplant under certain conditions to 82,000 acre-feet in year 2011, 62,000 acre-feet in year 2021, and zero in year 2031.

It has further been the position of the Bureau of Reclamation that in P.L. 90-537, Article II, the Congress declared that the first obligation of any water augmentation project planned pursuant to Section 201 of that act and authorized by Congress would be to provide water to alleviate the burden of the Mexican Treaty delivery requirement of the compact Article III C which might thereby make additional water available to the Upper Basin.

Mr. Coshland refers to a tree ring study that has been prepared by Dr. Charles Stockton in which Dr. Stockton concludes as a preliminary measure that the long-term average flow of the Colorado at Lee Ferry is between 13 and 14 million acre-feet. The 13.5 million acre-feet referred to by Mr. Coshland is an average of these two values. The Bureau of Reclamation has been active in reviewing the work done by

Dr. Stockton and has suggested that if funds are available from the National Science Foundation, Dr. Stockton refine his studies to eliminate some of the inadequacies that may have been introduced through the estimates of past use in the Colorado River Basin. These estimates of past use have a direct influence on the accuracy of the virgin flow, estimates which were used by Dr. Stockton in making his correlation, with the tree ring growth that was also produced by the same climatological conditions.

Until such time as the tree ring studies can be reviewed, revised and verified in order to establish a long-term synthetic streamflow record for the Colorado River that would be generally accepted, the Bureau of Reclamation believes that the 1906-1975 period or some other similar long period of recorded historical flow should be the basis for any hydrological determinations of water available in the Colorado River Basin. We are of the opinion that the flow data for the Colorado River at Lee Ferry for each year from 1906 to present is essentially of comparable quality, even though the records from 1906-1921 have been reconstructed by correlating with other main stream and tributary gages. Also, we are not aware of any major controversy among knowledgeable hydrologists that correlated records of the flow prior to 1922 are unacceptable.

Bureau of Reclamation studies are based on the Animas-LaPlata, Dallas Creek, Dolores, San Miguel and West Divide Projects being constructed and developed such that the full impact of their depletions would not be realized until after 1990 rather than 1985 as assumed by Mr. Coshland; but regardless of the date, depletions by these projects lie within Colorado's available water supply.

In summary, we believe that Mr. Coshland has arrived at an erroneous conclusion from his studies by not recognizing the 5.8 million acre-feet limit that is one of the basic premises of the Bureau of Reclamation water supply studies for the Upper Colorado River Basin. Any increase above this amount would result in an over draft of storage and result in dry reservoirs as indicated by Mr. Coshland's study. In his analysis, Mr. Coshland has also apparently allocated some storage space in Lake Powell to flood control. Although there is no formal flood control plan for Lake Powell requiring that space be provided for this purpose, the interaction of the flood control operation for Lake Mead and the requirement of the Coordinated Long-Range Operating Criteria (that after certain conditions have been met the active storage in the two reservoirs is to be maintained equal) might conceivably result in some minor quantity of water being released in high runoff years when the reservoirs of the CRSP system are nearly full that would be adverse to the interest of conserving water for consumptive use. The impact of this requirement on the 5.8 million acre-feet figure we have used to represent the limit of Upper Basin average annual consumptive use would be almost negligible when spread over the 34-year critical period (1931-1964). Also, our studies do not indicate that the part of the flood control space provided in Lake Powell as a result of splitting some of the Lake Mead requirement would likely be of nearly as high a magnitude as Mr. Coshland states. Mr. Coshland also may not be aware that irrigation projects can usually operate with short water supply during critical period of runoff.

We recognize the value of estimates of long-term records of water supply such as those provided by tree ring analysis. We also must recognize the fallibility of these data for precise determinations of water availability. The usable flow figures we have used are based on a long period of actual measured quantities and has to be recognized as a valid and defensible means of projecting future streamflow. The many records we have are usually of sufficient length as to minimize the probability of realizing future flows which are significantly different from those recorded. Furthermore, the record we have used is similar to the yield developed from the tree ring analysis.

In an arid region such as the Colorado River Basin, which has potential uses for water which far exceed the supply, we believe we would be remiss in not attempting to fully utilize the resource especially when the consequence of over-estimating the firm water yield of the basin would be shortages which would most likely have less adverse affect on the public interest than would an incomplete development of the resources.

We would be happy to review any draft of reply to Mr. Coshland's statement that the Bureau of Land Management may be preparing.

We are furnishing a copy of this letter to Mr. Hudgins of Arizona Public Service Company who has also asked us for assistance in responding to Mr. Coshland's statment.

E. J. Buster

cc: Mr. Terry D. Hudgins, Environmental Scientist
Arizona Public Service Company, P.O. Box 21666, Phoenix, Ariz. 85036

APPENDIX IX-2

Lake Powell Research Project Letter: Response to Letter From National Parks and Conservation Association

LAKE POWELL
RESEARCH PROJECT

An interdisciplinary study of a new lake in an arid land

Coordinators: ORSON L. ANDERSON
JERROLD E. LEVY

INSTITUTE OF GEOPHYSICS
UNIVERSITY OF CALIFORNIA, LOS ANGELES
LOS ANGELES, CALIFORNIA 90024
Telephone: 213 825-2386

December 1, 1975

Mr. Paul Howard
State Director
Bureua of Land Management
P.O. Box 11505
Salt Lake City, Utah 84111

Dear Mr. Howard,

RE: 2850 Kaiparowits (U913)

Enclosed is the official response of the Lake Powell Research Project to your query in response to a letter from R. L. Coshland of the National Parks and Conservation Association.

We asked Dr. Gordon C. Jacoby, Jr., our staff hydrologist, to prepare the response. Dr. Jacoby's response was circulated to the principal scientists of the Project who are connected with water and law research, for additional comments. Those principals decided Dr. Jacoby's comments could not be improved upon.

Sincerely yours,

Orson L Anderson

Orson L. Anderson
Natural Science Coordinator

OLA:jmv
Enclosure: 17 November 1975 letter from Jacoby to Howard
cc: G. D. Weatherford
G. C. Jacoby, Jr.
C. W. Stockton

APPENDIX IX-3

Gordon Jacoby Letter:
Statement Concerning Letter from National Parks and Conservation Association

Lamont - Doherty Geological Observatory | *Palisades, N.Y. 10964*
of Columbia University

Cable: LAMONTGEO
Palisades New York State
TWX-710-576-2653

Telephone: Code 914, Elmwood 9-2900

17 November 1975

Mr. Paul Howard
State Director
Bureau of Land Management
Utah State Office
P.O. Box 11505
Salt Lake City, Utah 84111

SUBJECT: 2850 Kaiparowits (U913)

Dear Mr. Howard:

This letter is a statement concerning the letter of 22 November by Mr. Robert L. Coshland, Arizona Representative of the National Parks and Conservation Association.

The overall point of the analysis by Mr. Coshland is generally correct. Certain assumptions should be modified but the overview is in accordance with some of the conclusions of the Lake Powell Research Project. The basic conclusion, jointly held, is that there is not enough surface water available for all the planned and projected consumptive uses presently envisioned for the Upper Colorado River Basin.

However, some caution must be taken with regard to projections of consumptive use. For example, the 1974 study "Report on Water for Energy in the Upper Colorado River Basin" lists water-using projects planned for the UCRB. The schedule for these projects is already greatly changed. Some plans have been postponed a year or more and the oil shale activities are in a very uncertain state at present.

As noted in the draft EIS, the State Engineer of Utah has not approved any new water-right applications for some time. One can assume or expect that new applications, if approved in the future, will receive very careful appraisal as to supply available, beneficial consumptive use aspects and priorities with respect to other uses. The Kaiparowits Power Project has a contract for the power-plant water supply. In the 1974 "Water for Energy" report used by Mr. Coshland as the basis for much of his analysis, many projected users listed do not have approved water-right applications. In view of the water supply situation, it is my opinion that some of these projects will not receive approval of their applications for water from present unaugmented surface-water supplies for some of the very reasons detailed by Mr. Coshland. If this conclusion of nonapproval holds true, the Kaiparowits Power Project water supply for the plant will be available past the 2005 date of Mr. Coshland's analysis. But it must be emphasized that this availability will exist only through some modification of the presently projected uses or modification of the presently estimated supply.

It is my opinion that Mr. Coshland's analysis points out very well what could take place (on a different time scale) if there is continued development as certain plans envision. Users, such as the Kaiparowits Power Project, would indeed run out of water if there is not substantial change or demand management program with regard to presently projected consumptive use projects.

Sincerely yours,

Gordon Jacoby

Gordon Jacoby

GC/ka
cc: O.L. Anderson
R.L. Coshland

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849